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DISCOVERY

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“The Literature of Discovery: 1920-1932”

includes the following articles—

HISTORY AND ARCHÆOLOGY. By Sir Frederic G. Kenyon

BIOLOGY. By Professor Sir J. Arthur Thomson

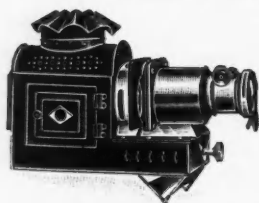
PHYSICS AND ASTRONOMY. By Sir Oliver Lodge

EXPLORATION. By Professor F. Debenham

Other Features and Book Reviews

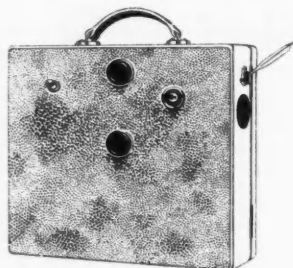
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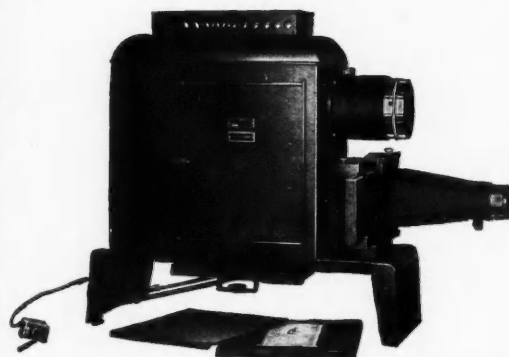
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DISCOVERY

A Monthly Popular Journal of Knowledge

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Notes of the Month.

WHILE our March issue was in the press a discovery of far-reaching importance was announced by Dr. J. Chadwick. Working at the Cavendish Laboratory, Cambridge, he has obtained evidence of a new kind of ultimate particle called the "neutron." About ten years ago its possible existence was suggested by Lord Rutherford to explain various problems as to the nature of matter, but only now has the neutron been confirmed as a definite factor in physics. The observation of particles and radiations has been undertaken for many years at Cambridge under Lord Rutherford's guidance, and it was in the course of this highly specialized work that the new discovery was made. Commenting on the neutron—"a massive particle with a positive charge of electricity in intimate contact with the mass-less unit of negative electricity, the electron"—Dr. A. S. Russell foresees an interesting future for it, as soon as it is firmly established in the body of atomic physics. "Mathematicians will begin with renewed energy to determine its place in the structure of the nucleus. Experimenters will examine its relation to the cosmic radiation. . . . Those who work in radioactivity will determine whether or not, in common with alpha- and beta-particles, it is expelled during the disintegration of atoms. . . . A particle which combines mass with enormous penetrating power is something of a wonder." (*Listener*, March 9th.) We shall publish further details as soon as information is available. Meanwhile, on another

page the photography of high-speed protons is described by some American physicists, who claim to have obtained these remarkable photographs for the first time.

* * * * *

This journal was founded on the view that a large public is interested in science. There had always been writers who "explained" the most difficult subjects in a way that required no thinking (and hence no real understanding) on the part of the reader. But the view that the expert might himself write for the man in the street was, in 1920, comparatively new. The war had brought millions of people into contact with applied science for the first time and they wanted to know more about it. The pioneer work of *Discovery* has been more than justified by the growth of this interest during the past twelve years. Books on physics, history or travel that previously sold in hundreds are now demanded in thousands, and publishers vie with each other in issuing "best sellers" in this field. As most of these books have been reviewed in our columns, we invited some distinguished critics to sum up the period in this Anniversary Number. Our contributors are Sir Frederic Kenyon, Sir Arthur Thomson, Sir Oliver Lodge and Professor Frank Debenham.

* * * * *

The public controversy which once attached to Darwinism has now shifted to the sphere of physics. Books on astronomy or the atom are given double-column headings in the newspapers, and Bishops debate with Professors on the ultimate nature of matter. But the biological sciences are as popular as ever, judging by the number of successful books, and most people are still more interested in living things than in metaphysics. Fortunately the different sciences are drawing together. At the British Association meeting General Smuts advanced the view that "physics and biology are simpler and more advanced forms of the same fundamental pattern in world-structure"; in any case, the gulf between them is now in process of being bridged. This new relationship is certainly helpful to the progress of

literature, as it is no longer possible to be a specialist to the exclusion of all other subjects.

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A discovery of great historical interest is reported from Giza, where Professor Selim Hassan is conducting excavations on behalf of the Egyptian University. According to an official *communiqué*, a new pyramid has been discovered bearing an inscription on the granite stone which had formed the entrance. It is now clear that the tomb was that of a queen whose odd title was King of Upper and Lower Egypt. The evidence suggests that she was the wife of the third king of the Fifth Dynasty. Several other burial places have also been unearthed, including a tomb which was found to contain a number of mummies. Each bears an inscription which enables the occupant to be identified. This is the first instance of a queen's tomb being separate from that of the king, and she was clearly a person of unusual importance; it is thought that she may have ruled as regent for her son. Further light will doubtless be thrown on the problem in the course of excavations.

* * * * *

Recent expeditions in Polar regions have attracted much attention. The voyage in the Antarctic of the research ship *Discovery II* was described in this journal last November. Meanwhile the sister ship *Discovery* has been engaged in Sir Douglas Mawson's expedition. An account of the work was read by Professor Debenham at a recent meeting of the Royal Geographical Society. Soon after entering the pack there was evidence of new land, but bad weather was encountered and the ship had to turn westward towards Enderby Land. Here a large bay was discovered, but after landing to claim the territory for Britain the expedition was obliged to return through lack of coal. The ship was refitted at Melbourne, and setting out again from Tasmania, was able to proceed farther south than on the previous voyage. New land was again sighted.

* * * * *

Perhaps the most important work carried out in Polar regions since the war is that of the British Arctic Air Route Expedition under the leadership of Mr. H. G. Watkins. It is now announced that a concession is likely to be made to the Trans-American Air Lines Corporation for maintaining a service from Detroit to Copenhagen via Iceland, "as long as no other company for this purpose is established." Facilities would be given for the building of an air port at Reyjavik and other services would not necessarily be permitted to make use of it. It is understood that seaplanes would be used for passing

the Greenland Ice Cap, skids being fitted to enable the planes to alight on the ice. The sole flying rights would be granted for a period of fifteen years, but if the service is not inaugurated by 1936 the concession could be cancelled. Incidentally plans are now being prepared for the erection of an adequate building for the Polar Research Institute at Cambridge.

* * * * *

Dr. Mortimer Wheeler has announced two interesting finds at Verulamium which have not been mentioned in preliminary reports. One is a unique token belonging to Mithras worship, the religion of the eastern sun-god which rivalled Christianity and had taken such a strong hold on the Roman army. The token is a coin of Augustus which originally had on the obverse the head of the emperor and on the reverse the representation of Tarpeia being overwhelmed by the shields of the Sabines. It has been pointed out to Dr. Wheeler that the reverse had probably been misunderstood as a scene of the nativity of Mithras. On the obverse the head of the emperor had been rubbed away and the inscription surrounding the word substituted. The second object is a bronze Celtic ornament of the "three-legged" type, with spirals for the "legs." The interest of this discovery lies in the fact that it belongs to a fourth century deposit and hence suggests the survival of a Celtic art in Britain even in late Romano-British times.

* * * * *

As a general rule we do not make financial appeals in these columns. But the scheme of the Society of Friends to provide useful work for 100,000 of the unemployed may well be an exception. Three years ago the Society started an allotments scheme for miners, which was so successful that in 1931 more than 64,000 men were assisted. On strictly "self-help" lines the men provide half the wholesale price of what they receive in the form of seeds, tools and the rent of allotments. Of £40,000 laid out on the scheme the men repaid £17,000 (mostly by instalments) and the estimated value of the vegetables produced was £400,000. Thus every £ spent provided £10 worth of food for the unemployed and their families besides giving them a useful and healthy occupation. Donations should be sent at once to the Allotments Committee, Friends House, Euston Road, N.W.1.

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A change is announced in the date of the International Congress of Prehistoric Sciences which is to meet in London this summer. The meeting will be held from August 1st-6th instead of in July as previously announced.

The Literature of Discovery: 1920-32.

The outstanding books published in various branches of research since 1920 are summarized below by distinguished critics. During the past twelve years more than two thousand volumes have been reviewed in DISCOVERY, and the following articles provide a valuable guide to the period. A classified list of the titles mentioned appears on page 136.

History and Archæology.

BY SIR FREDERIC KENYON.

GREAT histories do not appear in every decade, nor even in every generation, for the genius that can combine solid research with imaginative ordering and literary style is very rare. If from all the historical publications of the last twelve years one is to be selected as having the fairest prospect of immortality it would, in my opinion, be G. M. Trevelyan's *BLENHEIM*, the first volume of his continuation of the task left incomplete by his great-uncle. Nevertheless, the general output of historical work has been substantial both in quantity and in quality.

Possibly the most valuable part has been the continued research and publication of records. This country is almost incredibly rich in the materials of history, and societies and individuals have been industrious in publishing and calendaring them. The output of Pipe rolls, year books, episcopal and parish registers, and official and private correspondence has been great and meritorious; but it brings little reward in fame to the labourers. Most conspicuous, perhaps, is the publication of the *CORRESPONDENCE OF GEORGE III* by Sir John Fortescue. It should also be particularly noted that a very important step towards assuring the preservation, and ultimately the publication, of our national records has been made in the institution of local repositories under the auspices of the Master of the Rolls.

Of constructive work in the department of modern history, two other volumes of Mr. Trevelyan take a high place, his *BRITISH HISTORY IN THE NINETEENTH CENTURY* and his *HISTORY OF ENGLAND*. With them may be named two studies of diplomatic history, C. K. Webster's *FOREIGN POLICY OF CASTLEREAGH*

(a great man now at last coming into his rights), and H. W. V. Temperley's *FOREIGN POLICY OF CANNING*, and in another branch of political history, K. Feiling's *HISTORY OF THE TORY PARTY*. Two great works in the department of military history, Sir John Fortescue's *HISTORY OF THE BRITISH ARMY* and Sir Charles Oman's *PENINSULAR WAR*, have been brought to a successful

conclusion during the period; and special acknowledgment should be made of the excellence of the official histories of the great war by General Sir J. E. Edmonds and his colleagues. A masterpiece of erudition in a less inviting sphere is *THE HISTORY OF ENGLISH LAW* in nine volumes by W. S. Holdsworth.

In constitutional history the outstanding works of the period would appear to be the late T. F. Tout's *CHAPTERS IN THE ADMINISTRATIVE HISTORY OF ENGLAND*, and A. F. Pollard's *EVOLUTION OF PARLIAMENT*; while an intimate knowledge of mediaeval life and history is summed up in G. G. Coulton's *FIVE CENTURIES OF RELIGION*.

Abroad, several monumental works have been pursuing

their course and establishing themselves as the recognized authorities for their respective subjects, at any rate for their own generation. In France the *HISTOIRE DE LA FRANCE CONTEMPORAINE*, directed by M. Lavis, in Belgium, Professor Pirenne's *HISTOIRE DE BELGIQUE*, in Italy, de Sanctis' *STORIA DEI ROMANI*, and in Germany, Stern's *GESCHICHTE EUROPAS, 1815-1871*. A French historian, M. Halévy, has written an excellent *HISTOIRE DU PEUPLE ANGLAIS AU 19^E SIECLE*, and an Englishman, J. S. C. Bridge, has returned the compliment in an admirable *HISTORY OF FRANCE FROM THE DEATH OF LOUIS XI*. American research into their and our common history may be represented by the four volumes of the late H. L. Osgood's *THE AMERICAN COLONIES IN THE EIGHTEENTH*



SIR FREDERIC KENYON.

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CENTURY; and C. H. Haskins is only the most prominent among a number of American scholars who have been doing admirable work in mediaeval history.

Mediaeval Works.

In ancient history the mediaeval works which stand out most conspicuously are M. Rostovtzeff's HISTORY OF THE ANCIENT WORLD and his SOCIAL AND ECONOMIC HISTORY OF THE ROMAN EMPIRE, W. E. Heitland's THE ROMAN REPUBLIC and the late J. B. Bury's HISTORY OF THE LATER ROMAN EMPIRE, A.D. 395-565; but some of the most valuable work, alike in ancient and modern history, has been put into the collective publications which are characteristic of our days of intensive research. Among these the CAMBRIDGE ANCIENT HISTORY and the CAMBRIDGE MEDIAEVAL HISTORY easily take the first place; while for the popularization of history Hammerton's UNIVERSAL HISTORY, containing studies of successive periods by first-class scholars, linked with chronicles of events and copiously illustrated, is at once highly readable and more reliable than the widely popular OUTLINE OF HISTORY by H. G. Wells.

Little space has been left to deal with archaeology. Scholars and archaeologists have been busy in many parts of the world, and the reports of their discoveries have filled the publications of various learned societies. There are, however, many works in separate-volume form which deserve special mention. Pre-eminent among these is Sir Arthur Evans' magisterial PALACE OF MINOS; and with it, for scale of presentation and for importance of results, may be named Sir John Marshall's monumental volumes entitled MOHENJO-DARO, on his excavations in the prehistoric sites in north-west India. The most sensational discoveries have been those of the tomb of Tutankhamen and the buildings and royal graves at Ur. The former is described, with a wealth of illustration, in Howard Carter's TOMB OF TUTANKHAMEN, the latter in Leonard Woolley's reports in the *Antiquaries' Journal*, and in two small volumes THE SUMERIANS and UR OF THE CHALDEES. C. J. Gadd's HISTORY AND MONUMENTS OF UR also deserves mention. Among other reports special mention may be made of the French reports of the excavations at Delphi and Delos, edited by Homolle; Wiegand's account of Miletus; Noack's ELEUSIS; Dawkins' SANCTUARY OF ARTEMIS ORTHIA AT SPARTA; the American reports on Sardis; for Rome, invaluable work has been done in Platner and Ashby's TOPOGRAPHICAL DICTIONARY OF ANCIENT ROME; while in the department of classical architecture two admirable works have appeared in D. S. Robertson's GREEK AND ROMAN ARCHITECTURE and the new edition of Anderson

and Spiers' ARCHITECTURE OF GREECE AND ROME edited by Dinsmoor and Ashby.

Among volumes which sum up the results of archaeological research, the work on the largest scale is Baldwin Brown's THE ARTS IN EARLY ENGLAND. The series of volumes issued by the Historical Monuments Commission on London and the several counties, giving a well-illustrated inventory of all buildings and monuments prior to 1700, are of the highest value. Sir James Frazer's edition of THE FASTI OF OVID is a mine of information on Roman customs, beliefs and religion; and R. G. Collingwood's ARCHAEOLOGY OF ROMAN BRITAIN is an admirable handbook of existing knowledge of the subject. In a different quarter of the globe, Miss Caton Thompson's ZIMBABWE CULTURE has finally settled (for archaeologists) the main problem of the mysterious buildings of Rhodesia; and in the sphere of prehistoric archaeology a great service has been done to English readers by M. C. Burkitt's PREHISTORY. A new periodical which presents much archaeological information in a highly attractive form is *Antiquity*, edited by O. G. S. Crawford.

Much research by many scholars is summed up by J. L. Myres, with much constructive criticism, in his volume WHO WERE THE GREEKS?; and all over the world—in Egypt, Iraq, Palestine, Syria, China, India and Central America—no less than in the historic lands of Greece and Rome, exploration has been going forward, and many of its results may be found in the pages of *Discovery* during the years 1920-1932.

Biology.

BY SIR J. ARTHUR THOMSON.

It is often easy enough to record the growth of an organism through a dozen years, for we can measure its increase in size and weight; but it is very different with a science or group of sciences. Not only is a science something that cannot be put in the scales, its progress is often qualitative rather than quantitative.

The term biology is sometimes used to include all the biological sciences and sub-sciences—the "life-sciences," as the Americans sometimes call them. But it is also used, as in Spencer's PRINCIPLES OF BIOLOGY, to denote the general science of the nature, continuance and evolution of life. If we use it in this second sense, it seems fair to say that one of the characteristic book-features of our 1920-1932 period has been the number of studies on the biology of particular classes or even types. We mean books that show how particular kinds of organisms throw light on the fundamental characteristics of life. This educative type of book may be illustrated by

H. M. Kyle's *BIOLOGY OF FISHES* and Macgregor Skene's *BIOLOGY OF FLOWERING PLANTS*, two learned, original and thought-provocative studies. We may also mention G. H. Carpenter's *BIOLOGY OF INSECTS*, Th. Savory's *BIOLOGY OF SPIDERS* and Macgregor Skene's admirable *COMMON PLANTS*.

The general science of life must have much to do with vital activity—the problem of physiology. Perhaps the outstanding book-milestone here is the English translation of Pavlov's *CONDITIONED REFLEXES*, the term applied to the replacement of an old-established response by a new one which has come to be associated with it. Thus a hungry dog accustomed to the sound of an electric bell before the presentation of its food will by and by answer back, *e.g.*, by mouth-watering, to the ringing of the bell, although there is no other hint of food. This discovery has already had a far-reaching influence in physiology, psychology and educational theory.

During the last twelve years there has been, we think, a waning in the antagonism between mechanistic and vitalistic ways of looking at life. Since there is an illuminating chemistry and physics of the living body, there is what Comte called a "legitimate materialism"; but since chemistry and physics do not suffice to give an adequate description of the living, there is an autonomy of the organism. But we must not make a false antithesis of complementary aspects. As a vigorous representative of the mechanistic school we may mention Lancelot Hogben in his *NATURE OF LIVING MATTER*, while the other side is as ably championed by J. S. Haldane in his Gifford lectures, *THE SCIENCES AND PHILOSOPHY*, and his *PHILOSOPHICAL BASIS OF BIOLOGY*. A synthetic position which may be called "organismal" is defended by E. S. Russell in *THE STUDY OF LIVING THINGS*. As an instance of the rapid progress of biochemical physiology we may compare two books of the first rank—J. B. S. Haldane's *ENZYMES* with Sir William Bayliss's *NATURE OF ENZYME ACTION*.

Let biophysics be illustrated by Sir Arthur Keith's charmingly written *ENGINES OF THE HUMAN BODY*.

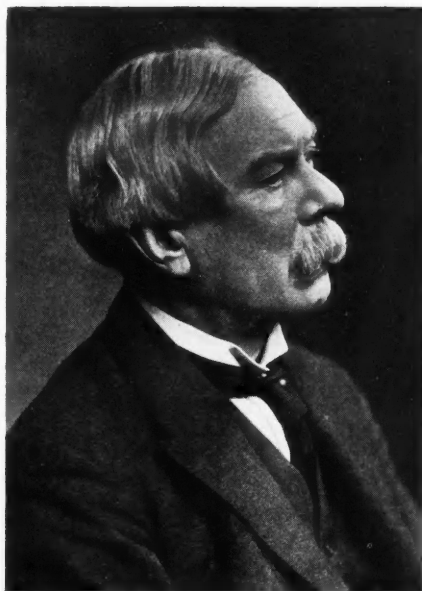
A high standard of lucid exposition marks *ANIMAL BIOLOGY* by J. B. S. Haldane and Julian Huxley, and *AN INTRODUCTION TO RECENT ADVANCES IN COMPARATIVE PHYSIOLOGY* by Lancelot Hogben and Frank Winton.

One would be missing one of the trends of recent years if one did not recognize the attention that is being given to the influence of hormones or regulative chemical messengers in the life of the body. Can we do better than refer to Sir E. A. Schafer's great treatise entitled *THE ENDOCRINE ORGANS*?

We are dealing here with books in English, and we do not know of any recent one that can be compared with Hempelmann's *TIER-PSYCHOLOGIE*. But anyone interested in animal behaviour and sex selection must take account of Eliot Howard's almost too luxurious *INTRODUCTION TO THE STUDY OF BIRD BEHAVIOUR*. More accessible is G. S. Gates's *MODERN CAT*, a luminous introduction to modern comparative psychology.

If we had to select for a new library twenty recent books dealing with natural history, we should begin with *THE SEAS* by F. S. Russell and C. M. Yonge, full of "meat" and full of beauty, a good story well told. If the library had a long purse (as it usually has, hasn't it?) we should add on this line William Beebe's *ARCTURUS ADVENTURE* and his "world's end" zoology entitled *GALAPAGOS ISLANDS*, Ponting's *GREAT WHITE SOUTH*, Flattely and Walton on *THE BIOLOGY OF THE SEASHORE*; we have enjoyed all these so much. The study of life in the seas has been well sustained during the last dozen years; and so it has been for other haunts of life. Thus there is Miss Kathleen Carpenter's admirable *LIFE IN INLAND WATERS*.

Treating of distribution as an evolution problem are several remarkable books, beginning with Ritchie's classic, *THE INFLUENCE OF MAN ON ANIMAL LIFE IN SCOTLAND*, and continued in Haviland's *FOREST, STEPPE AND TUNDRA*, G. M. Thomson's *NATURALISATION OF ANIMALS AND PLANTS IN NEW ZEALAND*, and the somewhat more recondite *AGE AND AREA* by Willis and others. These are really big contributions to biology.



SIR ARTHUR THOMSON.

Vandyk

As the years pass the old-fashioned natural history so well illustrated by Gilbert White, is changing into the sub-science of ecology, precise and often experimental. It is the science of inter-relations, habits and habitats; and we may illustrate its progress by taking as a type Landsborough Thomson's *PROBLEMS OF BIRD MIGRATION*, a resolutely scientific discussion of a subject too often treated anecdotally and with the amiable exaggerations of wonder-mongering. But we see in this precise and restrained treatise that old Topsell was right in saying that "God needeth not the lies of man." Beside it we may mention, as cognate, the third volume of T. A. Coward's admirable *BIRDS OF THE BRITISH ISLES* and Rabaud's awkwardly entitled *HOW ANIMALS FIND THEIR WAY ABOUT*, a study of "homing." Of great interest and freshness is Elton's *ANIMAL ECOLOGY*.

Herbert Spencer was partly responsible for pressing the misleading comparison of a human society with an individual organism and thus diverting attention from the true analogy between a human society and an animal organization, such as a beehive or an ant hill. Thus we welcome a careful study like W. M. Wheeler's *SOCIAL INSECTS*, full of new facts and new ideas and, alas! new terms. Beside it we would place Alverdes' *SOCIAL LIFE IN THE ANIMAL WORLD*, better described, however, by the original German title *TIERSOCIOLOGIE (ANIMAL SOCIOLOGY)*. Also within our period is the translation of that great treasure house of observations, Auguste Forel's *SOCIAL WORLD OF THE ANTS*.

The tracing of life histories from germ to senescence will not soon cease to engross the attention of biologists, but the tendency of the last dozen years and more has been to concentrate on the large problems of development in general, as is well illustrated by E. S. Russell's *INTERPRETATION OF DEVELOPMENT AND HEREDITY*, a masterly discussion of the indispensable concept of the unity of the organism. There has been of late a torrent of books on heredity.

Making Dry Bones Live.

New fossils of great interest continue to be discovered and described, but there is a notable change of mood among palaeontologists. They make the very dry bones live, reconstructing ancient scenes of the aeonic drama, seeing the whole in the light of evolution, and finding laws of life amid the long since dead. Thus we venture to single out on the plant side D. H. Scott's *EXTINCT PLANTS AND PROBLEMS OF EVOLUTION* and A. C. Seward's *PLANT LIFE THROUGH THE AGES*. Very important on the animal side, with its revelation of the pedigree of mammals, birds and

reptiles is R. Broom's *ORIGIN OF THE HUMAN SKELETON*, which shows us the pit whence we were dugged and the rock whence we were hewn. We are not forgetting the revised edition of Sir Arthur Keith's *ANTIQUITY OF MAN*.

From Fact to Factors.

Darwin's marshalling of the evidences of evolution was so convincing that biologists were free to pass from the fact to the factors; and that enquiry becomes ever more precise and critical. Variation and heredity, selection and isolation are all being studied with great intentness and at a high level of accuracy. In our judgment the most important recent investigation is R. A. Fisher's *GENETIC THEORY OF NATURAL SELECTION*, particularly to be recommended to impetuous writers who tell the public that Darwinism in the stricter sense is dead. The theory of natural selection, rehabilitated through Mendelism, is very much alive.

One of the salient features in recent aetiology (*i.e.*, evolution lore) has been the recognition of the more or less open secret expressed in the term "emergent evolution." Who would have expected that the two gases, hydrogen and oxygen, could combine to form such a new thing as liquid water, an "emergent," not a mere additive resultant, and one of the highest importance in evolution? Now it has become evident that the Ascent of Life has been a succession of "emergent" steps, novelties that are creative rather than "additive," such as birds from ancestral reptiles, and, in supreme instance, man from an anthropoid ancestry. As a protagonist of this view we cite the veteran Lloyd Morgan in his *EMERGENT EVOLUTION*.

Some important general treatises have appeared during the last dozen years, and we may select Woodger's *BIOLOGICAL PRINCIPLES*, and Ritter's *UNITY OF THE ORGANISM*, which was published just about the beginning of our period. It would be ungrateful not to recall the biological articles in the new edition of the *Encyclopaedia Britannica*, such as Singer's study of biology and Goodrich's on evolution. A book to be grateful for is Charles Singer's *SHORT HISTORY OF BIOLOGY*, which will, we hope, give a stimulus to increased historical study among biologists themselves as well as among the educated laity. It is a scholarly, lucid, shrewd book, with interesting illustrations.

Characteristic of our time and well illustrated in the last dozen years is the application of biological science to the problems of human life, practical and hygienic, ethical and social. Outstanding in its lucidity and wide appeal is *THE SCIENCE OF LIFE* by H. G. Wells, Julian Huxley and G. P. Wells. It is a

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hopeful sign of the times, a fine outcome of Comte's ambition: *Savoir, pour prévoir, afin de pourvoir*. Among other books of similar outlook may be mentioned: H. S. Jennings' *THE BIOLOGICAL BASIS OF HUMAN NATURE*, S. J. Holmes' *THE TREND OF THE RACE*, E. V. Cowdry's *HUMAN BIOLOGY AND RACIAL WELFARE*, a co-operative volume, and another like it, *BIOLOGY IN HUMAN AFFAIRS*, edited by E. M. East, and Hogben's *GENETIC PRINCIPLES IN MEDICINE AND SOCIAL SCIENCE*. The biological day, heralded by Pasteur and Galton, has at last dawned.

Many biologists make valiantly for the progress of their science without ever writing a book, but thinking of books in English, we have taken a retrospective glance at biological advance during the dozen years since *Discovery* was started. Our limited space, not to speak of our limited knowledge, will account for many egregious omissions; but we venture to think that our survey demonstrates the remarkable and many-sided progressiveness of the life-sciences.

Physics and Astronomy.

BY SIR OLIVER LODGE.

AT the beginning of the period under review, many authors were writing enthusiastically about the structure of the atom. Bohr's *THEORY OF SPECTRA AND ATOMIC CONSTITUTION* appeared in 1922; and in the following year came

Professor Andrade's *THE STRUCTURE OF THE ATOM*, a "seasonable" attempt, as he says in his preface; also my own book called *ATOMS AND RAYS*. About the same time came *THE NEW PHYSICS* by Haas.

But this new physics was soon to be revolutionized further by De Broglie and Schrödinger, with their enthusiasm for the new wave theory of matter. Schrödinger's mathematical lectures delivered at the Royal Institution in 1928 were published as a little book called *WAVE MECHANICS*; De Broglie wrote under the title *AN INTRODUCTION TO THE STUDY OF WAVE MECHANICS*. Sir J. J. Thomson contributed a brilliant expository work in *BEYOND THE ELECTRON*. Quite recently we find his son, G. P. Thomson, writing on a branch of the same subject, which he has made

his own, *THE WAVE MECHANICS OF FREE ELECTRONS*. And Professor C. G. Darwin has treated of the most recent ideas in his book *THE NEW CONCEPTIONS OF MATTER*.

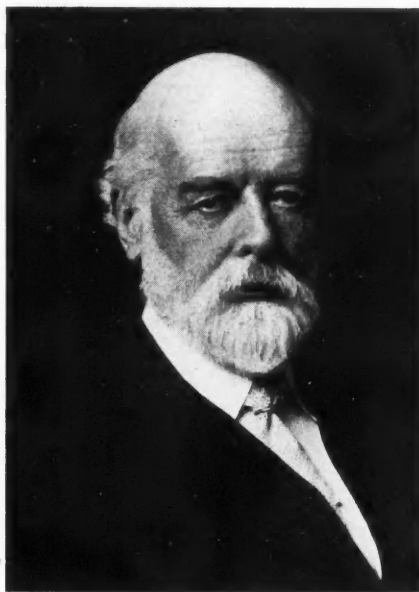
Planck's contribution of the quantum was made before the beginning of the period under review, but throughout the decade expository books have appeared, such as *THE ATOM AND THE BOHR THEORY OF ITS STRUCTURE* by Kramers and Holst. Professor Graetz's *RECENT DEVELOPMENTS IN ATOMIC THEORY*, and (more advanced) *THE MECHANICS OF THE ATOM* by Max Born, also *THE QUANTUM AND ITS INTERPRETATION* by Professor Stanley Allen, Heisenberg's *THE*

PHYSICAL PRINCIPLES OF THE QUANTUM THEORY, and last year Planck himself summed up the present position of physics in *THE UNIVERSE IN THE LIGHT OF MODERN PHYSICS*.

But it has been almost too prolific a time in physics. New ideas have been born almost before the old ones have been assimilated. Authors must sometimes have feared that the ideas they are expounding may be out of date before their books are through the press. There are mathematical treatises by Eddington and Jeans, that space forbids my mentioning; though I must not omit to include H. A. Lorentz's *LECTURES ON THEORETICAL PHYSICS* dealing with aether theories, aether models and kinetic problems.

Of more popular writings, a noteworthy expository book was Sir William Bragg's *CONCERNING THE NATURE OF THINGS*, his Royal Institution Christmas lectures. On the astronomical side, in 1923 Sir Richard Gregory re-wrote a second edition of *THE VAULT OF HEAVEN*, and the late Professor H. H. Turner issued *A VOYAGE IN SPACE*, being a course of six lectures delivered to the juvenile audiences at the Royal Institution.

But most of the other books I have mentioned will not be intelligible to the ordinary layman. They are written for professed students of the subject, and some of them for those endowed with extensive mathematical knowledge. They hardly claim to be "literature." But fortunately it happens every now



SIR OLIVER LODGE.

and then that someone exceptionally competent in a recondite direction is also able to express himself in plain English, and to issue books which are readable and intelligible both to the philosopher and to the ordinary man who takes an interest in scientific questions. Two such Englishmen have of late become especially noteworthy, and have caught the ear of the public to a remarkable degree. One of these is Sir Arthur Eddington, and the other is Sir James Jeans. Both their popular books have been published by the Cambridge University Press; the one in 1928, called *THE NATURE OF THE PHYSICAL WORLD*; the other in 1929, called *THE UNIVERSE AROUND US*.

During the present century there has been a revolution in physical science, and some of its results can be expressed in paradoxical fashion. Semi-astronomical experiments are imagined which cannot be performed, and the consequences deduced from theory for them are very peculiar. Eddington's book rather emphasizes these paradoxes, and thus has awakened extraordinary interest in subjects of surpassing difficulty. Jeans's book is a more straightforward account of some of the recent progress in astronomy, guided by a theory to which he has himself largely contributed; and it has attracted widespread attention because, as he himself eloquently says, astronomy may be regarded "as the most poetical and most aesthetically gratifying of the sciences." It exercises the imagination on things "remote from everyday trivialities," and introduces us to "the serene immensities of the outer universe." Its value as a study lies not in its utilitarian character, which is very minute, but in its enlargement of our ideas, so that "it provides something of the vision without which the people perish."

Philosophical Speculations.

Incidentally, the authors speculate on the meaning and philosophic significance of what has been discovered; and to those speculations there have already been some replies—among others a volume recently published called *SCIENCE AND HUMAN EXPERIENCE*, by the honorary secretary of the Royal Astronomical Society, Dr. Herbert Dingle. And Professor Whitehead has also subjected some of the ideas to a weighty and well-informed criticism in his book *SCIENCE AND THE MODERN WORLD*, in which he contends against many things which in modern science are in danger of being prematurely accepted. He contends against scientific materialism, on the one hand, and on the other, he denounces the extreme use of abstraction, which has a tendency to substitute purely mental concepts for concrete facts. "The

intolerant use of abstractions," he says, "is the major vice of the intellect."

So the great men are not having it all their own way; fortunately they dispute among themselves; and it will, I presume, be for the philosophers, who try to take *the whole* into their purview, to have the last word.

Meanwhile physical science is in a most interesting condition, and is continually giving birth to new theories and new experimental results; all of which must be taken into account before there is any hope of settling down into a placid orthodoxy like that of the nineteenth century. When the strivings have subsided, there will doubtless be a scientific orthodoxy again. It will not be the same; it will be, let us hope, improved and enlarged; for it will not be satisfied with the material universe alone, but will take into account parts of existence which science now for the most part ignores.

Travel and Exploration.

BY PROFESSOR FRANK DEBENHAM.

It may be regrettable, but it is none the less inevitable, that any selection of books in a given period must be influenced by personal prejudices and preferences, unless indeed it be the outcome of a formal census of opinion. This review, therefore, makes no claim to represent the verdict of the general public, nor does it attempt to justify itself by sheltering behind the dicta of either the reviewers or the booksellers.

Amongst the outstanding books of travel of the last twelve years, probably few people would fail to give prominence to *THE WORST JOURNEY IN THE WORLD*, the account of the chief events of Captain Scott's last expedition in the Antarctic, written by A. Cherry-Garrard, the sole survivor of the particular winter journey so described by Scott himself. There are several reasons why this book will live, but two of them will suffice. The first is that it is written precisely as though it were a quiet and balanced talk to a friend, and the second is that it achieves a rare intimacy with the reader, even in its defects. The occasional too trenchant criticism, the personal shudders at too acute a memory, give the reader a glimpse into the feelings of a man whom the events which he relates have affected deeply, yet without a suspicion of egotism.

It is, after all, quite a natural step from this book to *THE SEVEN PILLARS OF WISDOM*, or its abridged form, *REVOLT IN THE DESERT*, by T. E. Lawrence. Both deal with stirring events and notable characters in extremes of climatic discomfort, but there the

resemblance ends. It would be going too far to say that the one is pure drama and the other melodrama, but that at least hints at the nature of the difference; yet the bold cast of the book triumphs over its obvious defects, the occasionally affected style, the unpleasant candour, the egotism so carefully hidden that it shouts aloud.

Arabia seems in some strange way to cast a special spell of style upon its travellers, or it may be that the quaint, incomparable manner of Doughty has been passed on subconsciously to those who have followed him. However that may be, it is certain that the latest book about Arabia has a strain of Elizabethan English in it, and is worthy of the great journey it narrates. *ARABIA FELIX* enters the literature of Arabian travel with as sure a step as its author, Bertram Thomas, entered the forbidden corner of that fanatic land.

It is not always thus: the great adventure does not always find the great narrator. The attempts of the last decade on Mount Everest have not presented us with any one book which compares with the magnitude of the task attempted. Yet if only for its skilfully recorded facts, *THE FIGHT FOR MOUNT EVEREST* must be noted here. It is the work of several authors, as was indeed necessary to secure eye-witness narratives, but it thereby loses the appeal which a single author often claims.

Quite otherwise in the force of its personal appeal is *THE KANCHENJUNGA ADVENTURE*. Smythe's record of this unsuccessful attempt upon a high mountain is remarkable because of its easy and informative style, and its exceedingly skilful journalism, using the term in its best sense.

To find a really outstanding book about mountains, though not about the climbing of them, we must turn to *THE RAINBOW BRIDGE* by Reginald Farrer, a sequel to his *EAVES OF THE WORLD*. Because of his reputation as a collector and writer on alpine plants, the world has probably failed to appreciate this R.L.S. of Thibetan travel. A scholar to his finger-tips, he wrote prose of a lyrical sweetness with a quality of simplicity and ease rarely equaled since the Vailima letters.

From a book so enthralling in its faultlessness it is strange to turn to one full of faults, yet a remarkable book in spite of them. Stefansson, in his *THE FRIENDLY ARCTIC*, does not lead the reader gently by the hand to strange places, as does Farrer; he exhorts, he cajoles, he gibes, he threatens him, till he feels bludgeoned into believing that the Arctic is friendly; he preaches and lectures rather than entertains. Yet the polar library cannot do without its Stefansson, even if his logic is somewhat too perfect, his conclusions a thought too unassailable. Neither can it do without *SOUTH*, Shackleton's plain yet skilful tale of his *Endurance* expedition, and a boat journey which will live as long as books of travel are read.

At some such point as this the reviewer loses heart in his attempt to range in any order of excellence a veritable host of books, and takes refuge in a lame recital by continents. That monumental work *SERINDIA*, by Sir Aurel Stein must be noticed, although it is on the border line between books and scientific reports. For Africa two books may be mentioned, *SUN, SAND AND SOMALIS* by Major Rayne and Hassanein Bey's *LOST OASES*, the latter remarkable for its perfect English as well as for its stirring story. A close parallel is Knud Rasmussen's *ACROSS ARCTIC AMERICA*. For South America we might select *GREEN HELL* by Duguid for its vivid style and clear



PROFESSOR FRANK DEBENHAM.

picture of an out-of-the-way corner of that continent, slightly reminiscent of Tomlinson's works, which are perhaps hardly geographical enough to come into this list. Of books which deal with the personal recollections rather than specific journeys, one cannot omit Lord Curzon's *TALES OF TRAVEL*, which is all that one would expect from such a scholar. Mention of that book recalls Lord Ronaldshay's *LANDS OF THE THUNDERBOLT*, although this is more definitely narrative of particular journeys. Both remind us that the really great administrator is able to explore, and to produce an outstanding account in spite of the pressure of official duties. Finally we cannot refrain from adding Alain Gerbault's *IN QUEST OF THE SUN*, the story of his sailing round the world alone.

"Finger Prints" of the Voice.

By E. W. Scripture, M.D., Ph.D.

Professor of Experimental Phonetics in the University of Vienna.

An apparatus for studying speech visually is being applied in the diagnosis of certain diseases. The author suggests that no two voices are exactly alike, and that a great deal can be discovered from vocal "finger prints."

SOME films recently produced by Dr. W. Lenk of Vienna give new information concerning the nature of speech. An analysis of the films provides mathematically accurate data concerning the speaker himself which are already proving of great importance. If an impresario wishes to know whether a famous singer's voice is worth a large salary, he can determine the quality of the voice by subjecting the film "curves" to mathematical analysis under the microscope. If a neurologist wishes to obtain a sure diagnosis in cases suspected of certain diseases, a concealed microphone will furnish film curves that give definite information regarding paralysis and epilepsy.

A photograph of the apparatus used by Dr. Lenk is given on the facing page, and also a diagram to illustrate the principle. The light from a lamp illuminates a slit 0.1 mm. wide. Just behind this slit is a wire 0.2 mm. thick which covers the slit but crosses it at an angle. The wire is stretched between the poles of an electromagnet and vibrates in accordance with the current received from a microphone in response to voice vibrations. As it vibrates it uncovers more or less of the slit and allows the light to pass through to a moving film (in the box on the right in the photograph). When the film is developed it shows a band of variable area, the edge of which is an exact record of the vibration of the air during what was said. By passing the film between a light and a selenium cell or a photocell the film can be turned into speech again.

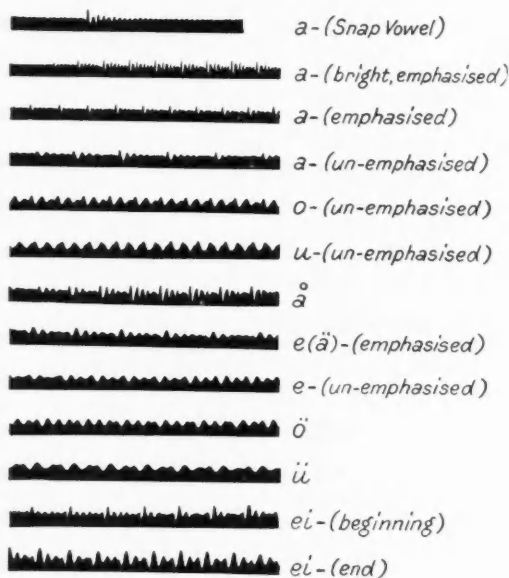
As already mentioned, a single glance at the film gives information concerning creeping paralysis (disseminated sclerosis); it takes hours of work to

measure and calculate the curves for general paralysis and two or three days to do the work on an epileptic film. But the answer is absolutely sure. Cases of creeping paralysis often go for a long time unrecognized because there is no reliable test except that in speech curves. Cases of general paralysis can be detected in the earliest stages and cured by suitable treatment before it is too late.

The accompanying figure shows a film record of various vowels. At the top is a record of the vowel *ah*. This is a short clear *ah* produced by a single click from the larynx with the mouth in a position for *ah*. A similar sound can be produced by shaping the mouth for *ah* and slapping the cheek; some persons can make excellent snap vowels of all kinds by jerking the thumb suddenly out of the mouth. Everybody can make all the snap vowels by single clicks from the larynx. A snap vowel is a perfect vowel; it differs from other vowels only in being momentary instead of continuous.

The film curve for a snap vowel shows a complicated wave that starts strong and fades away. The fading shows that the air vibrations are what the telephone and wireless experts call "transients," that is, vibrations that start strong and fade rapidly. The complicated form shows that several transients are present.

This establishes the fundamental fact that a snap vowel is the sum of a set of transients. Nothing else appears in the film curve. There is no record of the snap from the larynx; it is the *cause* of the transients but it is not a sound itself. There is no vibration from the larynx and no voice tone. The



FILM RECORDS OF VOWELS.

As recorded by the new apparatus, each vowel has its own type of curve. Details are described in the text.

transients consist of vibrations in the vocal cavities. Physiologically, therefore, a snap vowel consists of transient vibrations of the vocal cavities aroused by a snap from the larynx.

The second line in the illustration is a registration of *ah* spoken "brightly." It shows a succession of snap curves overlapping slightly because one snap curve does not have time to fade entirely away before the next one begins. We can at once draw the

conclusion that a continuous vowel consists of a series of snap vowels with more or less overlapping. In other words, a continuous vowel consists of repeated sets of transients. The snaps that produce the transients do not appear in the curve. Physiologically a continuous vowel consists of a succession of sets of transient vibrations of the vocal cavities produced by a series of glottal snaps. The repeated sharp snaps from the glottis with pauses between them are not of the nature of vibrations; the vocal cords do not vibrate in producing the vowels.

Let us call the form of the film curve for a single snap a "profile." It is really a profile with much the same character as a face. Compare the curves for the different vowels in the illustration. Each kind of vowel has its own type of profile, much as the faces of different races have. Now look at the profile in the second line. They are all of the same type—the bright *ah* type—but each one differs slightly from the preceding one. It is just as though the speaker could not keep his face straight. That is exactly what happened—and must happen in every case. A vowel profile is the result of muscular adjustments of the vocal cavities. Only a dead man or one with some such diseased condition as Parkinsonism or post-encephalitis can keep his muscles immovable. In a live man the muscles are moving all the time to express his internal impulses. The vowel profiles express not only the motion of this or that vowel but also the speaker's emotional state, his character, and, in

short, his whole inner self. A continuous vowel may be regarded as the person's vocal "signature" on the cheque drawn on his constitution to pay the demand for the particular vowel.

Let us stop for a moment to consider "sound signatures." Everyone has his own that shows itself in all vowel profiles. It reveals not only the quality of his voice, but also—to one who knows how to interpret the curves—his emotional condition and

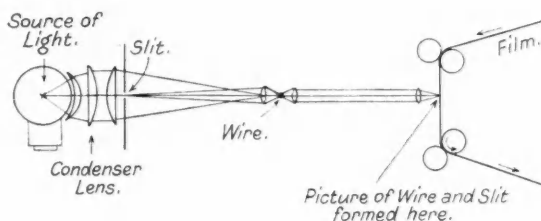
his character. The signature can be caught by a concealed microphone or from wireless waves and can be registered on a film.

One quarter of the cases now diagnosed as epilepsy are not epileptic at all; film curves would save them from a serious stigma or institutional treatment. Last year the question of epilepsy was raised at a murder trial; no reliable information either way could be obtained from medical opinions. A film curve would have settled the point. Aeroplanes, machinery of every sort and even rooms each have their own sound signatures, and successful action or defects can be diagnosed by film curves; but that story does not belong here.

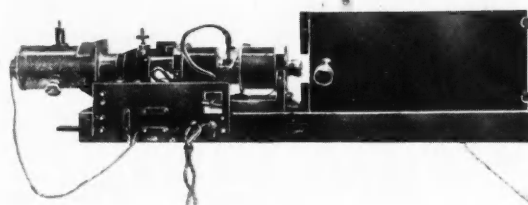
Another application suggests itself at once. At an examination of an accused person by the police or before a court nothing more can be done than to write down what the person says. A film curve would record not only what he said but also how he said it. It could be reproduced so that everyone could hear it and judge it. Especially important is the possibility of

analysing the curves and getting at the details concerning the person himself. A film curve can, indeed, be used as a finger print of the voice. No two voices are alike, and even if a person tries to speak in a disguised voice he cannot imitate a perfectly natural one and cannot keep up the disguise indefinitely.

Further applications may be made almost interminably. The voices of important people or of valuable speech or song should not be lost.



THE PRINCIPLE OF THE APPARATUS.
The "curves" obtained give important information concerning the speaker.



THE "CAMERA."
A photograph of the apparatus used in recent work by Dr. Lenk at Vienna.

They can be preserved as gramophone records, but such records are not visible to the eye and cannot be measured and analysed except by laborious methods. Why not use a concealed microphone and make film curves? That the records can be multiplied and preserved indefinitely is not the chief result; the valuable fact is that the curves can be analysed down to the finest details.

The work of dialect societies and institutions—often supported at great expense—is of small value because all that is done is to note down with a set of letters what is supposed to be said. No two persons ever agree on just what letters to use, and the most important facts concerning dialects—the fixity of type, gradual changes, etc.—go unobserved and unrecorded because no accurate methods are used. Attempts have been made to remedy the defect by making gramophone records, but two persons trying to interpret a record always disagree. What would be simpler or more efficient than to make film curves and analyse them under a microscope?

One achievement of the film curves is that they constitute the burial service of an antiquated theory concerning the nature of the vowels. On the basis of experiments with vibrating reeds and cavities of different shapes Willis of Cambridge suggested in 1830 that vowels were the results of sharp impulses of air from the larynx acting on the air contained in the vocal cavities. This was accepted as self-evident by Helmholtz. In spite of this a theory grew up according to which a vowel consists of a sine vibration of the length of the profiles with a set of further sine vibrations with frequencies in the relations 1, 2, 3, The differences between the different vowels are supposed to arise from variations in the amplitudes of the various sine vibrations. The film curves show that a sine vibration of the length of the profile—the fundamental—is *never* present and that no sine vibrations in the relations of 1, 2, 3, ever occur.

A Popular Fallacy.

The salient fact that sine vibrations of any kind do not occur in the vowels is what distinguishes them from the tones of musical instruments. No musical instrument can imitate the vowels unless it can produce sharp puffs acting on the soft walls of a cavity that can change its shape from instant to instant. Volumes have been written in support of this "overtone theory." It has come to be accepted as a kind of religion whose teachings are not to be questioned. It appears in every textbook of physics as an incontestible fact like the shape of the earth. It has

not a fact to support it and every fact is against it. People have been trying for years to kill it by citing the facts; it is to be hoped that the publication of film curves will bring about a speedy demise.

It has perhaps dawned on the reader that these film curves show that a vowel is not a simple matter but is a complicated structure involving the whole bodily and mental personality of the speaker. In fact, just as the atom of our former day has passed through the stage of being resolved into a solar system of a proton and electrons with elliptical orbits and quantum phenomena, the vowel has been found to be a speech element of immensely complicated character that expresses the results of the still unknown laws of the unconscious mind and the whole bodily system.

Acceleration and Human Beings.

INFORMATION on the effect of accelerations in human beings is somewhat rudimentary with the single exception of observations made on aeroplanes. Aircraft in general have to be built to certain factors of safety so as to keep the total flying weight as small as possible, and for this reason accelerometers have been carried to measure the resultant forces experienced in flight. In this way a measure has also been obtained of the forces impressed on the pilot. The practice of flying has gradually developed by the careful training of the pilots so that undue stress is not placed on the aircraft structure, and this has been made possible by the pilot using his physical sensations to limit the violence of any aerobatic manoeuvre.

Describing recent experiments in the *Journal* of the Royal Aeronautical Society, Mr. J. L. Nayler says that the average pilot seems to suffer no discomfort during ordinary manoeuvres. Individual records of "pull-outs" from a dive have registered high accelerometer readings without the pilots experiencing ill effects. On the other hand some Schneider Trophy and other high speed pilots have stated that on a continuous turn at a high speed they see "black" although their muscular sense remains. In sport there are many records of sprinters and jumpers breaking a bone during the take-off. But the bony structure of the human being is liable to break if it is subjected to more than twelve times its weight.

One reason for suggesting that present flying practice may be well within physiological limits arises from a consideration of the more strenuous sport of dirt-track racing, where drivers have found it necessary to wear elastic belts to support their abdominal organs. Any acceleration experienced in an aeroplane has not warranted the adoption of belts by pilots.

Science and Industry—II**New Knowledge of Food.**

By Sir William B. Hardy, F.R.S.

An abundance and choice of food throughout the year is taken for granted to-day, but less than a century ago winter food was scarce and semi-starvation was not uncommon before the end of the year. One of the latest achievements of science in this field is the gas storage of fruit, which cannot be frozen in the same way as meat.

WHEN I was asked to contribute an article on food, showing how science is helping to solve everyday problems, the first question which came to mind was: what are the everyday problems of food? The "everyday" problem is, I take it, that which pertains to the "ordinary" household, and so far as food is concerned it is the problem of how to be able to pay for and how to be able to buy enough good food and hold it in good condition until it is consumed. Of these the first does not concern me, it is the economic problem, in the main the man's problem. The second does and in the main it is the woman's problem.

The Store of Vitamins.

It is not so simple as it seems at first sight. What determines "enough" and what are the criteria which food must satisfy to be good? My space could be used up many times over on either of these, so I must be brief and didactic. "Enough" can be defined in two main ways: there must be enough to make good loss of material and of energy and there must be enough and of the right quality to maintain the store of vitamins. I need not at this late date stress the profound differences between these two definitions beyond saying that the second is more difficult and exacting than the first.

"Good" is even more difficult to define. In the first place there are dietetic idiosyncrasies so that only a broad average statement is possible. In the second place, quality is hedged about with many unknowns for diet is still largely a mystery. For example, take that aesthetic quality best connoted by "palatability"; what part does it play? The answer depends entirely upon where you look for it. Pavlov's experiments on the influence of the nerves on gastric secretion indicate that palatability, if not necessary is at least an important aid to digestion. On the other hand there is a little-known but highly important experiment carried out during the war which points exactly in the opposite direction. In its way it is a small classic of biochemistry.

There was great outcry about the indigestibility and ill effects on general health of war bread, which contained a large percentage of maize and was milled from grain which would find little favour in normal times.

The Royal Society was therefore asked to conduct, and did conduct, a detailed enquiry in which war bread and good wheaten bread were matched against one another, the war bread being of an exceptionally bad quality. The results were curious and certainly unexpected. In actual digestibility the two breads came out dead level, and the ill effects on health so clamorously charged against the former appeared to be imaginary.

Batches of war bread and of wheaten bread prepared in such a way as to look as nearly alike as possible were tasted at various places, amongst them being a large factory in Yorkshire. The first batch sent out, enough to last for some weeks, was war bread but by a pure clerical error the factory was informed that it was wheaten bread. The employees, therefore, ate war bread for some weeks under the impression that it was wheaten bread, with the result that the doctor in charge reported enthusiastically on an improvement in general health! The employees were more cheerful, complaints of indigestion ceased and even chronic complaints cleared up, in spite of the fact that they were eating war bread worse than what they had been having previously. If the report is a classic of biochemistry, it is also a classic of faith-healing!

Must food be free from taint by moulds or bacteria? The answer to-day would be an emphatic "Yes." But the dislike for tainted food, so strong nowadays as to seem a deep-rooted instinct, has perhaps no deeper significance than habit in view of the state in which game was brought to table a few generations ago. However, the philosophy of diet fortunately is not my subject and I have said enough to show that the ideals to be aimed at in the handling of food are not as securely based on accurate data as is sometimes thought.

Varied Diet.

The only thing to do is to accept the broad decision of mankind based on the massive experience of generations that diet should be varied and that it should contain a large proportion of fresh food; and by fresh food one means actually living fruit and vegetables and meat which has suffered no more than normal post-mortem change. But even that

acceptance has to be made with half an eye on the curious changes which fashion or economics bring about. Barrows in the streets are covered nowadays with fruit, but in the early part of last century they must have been covered with shellfish, for did not Mr. Sam Weller, whose knowledge of eating and drinking was extensive and peculiar, declare that "poverty and oysters always seem to go together. . . . Blessed if I don't think that ven a man's very poor, he rushes out of his lodgings, and eats oysters in reglar desperation."

What science coupled with invention has done in providing fresh food and enough of it can be best realized by contrasting the conditions which obtained up to at any rate the beginning of the last century with those of to-day. The mediaeval housewife had few shops to go to even when she was within reach of a country town such as Norwich. Only in London, as the Paston letters show, was there a reasonably large store to draw upon. She was in the position of a farmer's wife in a farm hidden away in some remote corner where, as a sixteenth century ballad says:

"Some respit to husband the weather may send
But huswiues affaires haue neuer an end."

The climax of the year was the harvest, for the country lived literally from hand to mouth. If the harvest failed there was no income of food from abroad sufficient to make good deficiencies. Therefore the autumn was a time of feasting and plenty:

"In haruest time haruest folk, servants and all
Should make all together good cheere in the hall
And fill out the black boule of bleith to their song
And let them be merie all haruest time long."

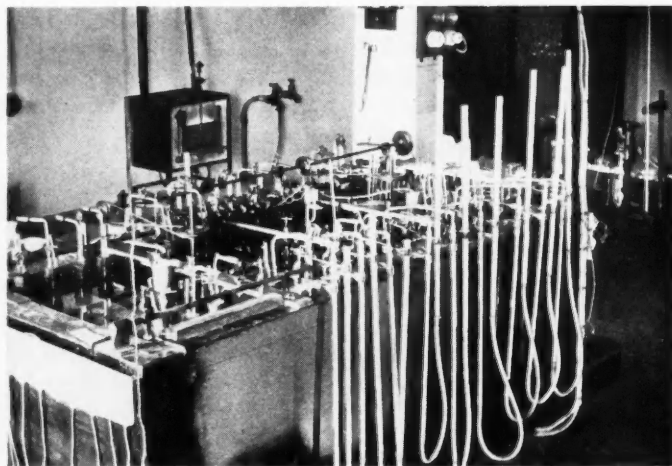
But the plenty was apt to fade into semi-starvation and even famine before the end of the year came round again. The picture may be overdrawn, but here is what Stow says of an English famine: "Some (as it was sayde) compelled through famine, in hidden places did eate the flesh of their owne children."

Winter food was scanty, and therefore beasts were slaughtered in the autumn and the flesh salted down or pickled and a

store of fish had to be bought, herrings red or white in barrels, with dried fish, ling, cod, salmon or eels. Dried or pickled food was indeed the standby to enable folk to live through the cold and gloom of winter: not only dried fresh meat or fish but also dried peas and beans. The food was rough, inconceivably so to us, the dried fish so hard that it had to be softened by beating on a "stock" and hence its name "stock-fish." The "Northumberland Household Book" gives us a glimpse of the type of food used in even so great a household as that of an earl: "Braikfast for the Nurcey for my Lady Margaret and Maister Ingeram Percy. Item a Manchet a Quarte of Bere a Dysch of Butter a Pece of Saltfisch a Dysch of Sproites or iij White Herryng. Breakfast for my Ladis Gentyll-women. Item a Loof of Brede a Pottell of Bere a Pece of Saltfisch or iij White Herryng." Scurvy cannot have been far away from a mediaeval household in spring.

The yearly rhythm of plenty and scarcity lasted long after mediaeval times: everyone will remember how Thomas Hardy recalls in "The Mayor of Casterbridge" the importance of the home corn trade in the early part of the last century, and contrasts it with the "present indifference of the public to harvest weather." Vegetables were absent during the winter from the menus of the Royal Society Club in the eighteenth century. Contrast all this with the abundance and choice now open to the housewife, which is taken for granted. Science and invention between them have made an abundance which has not only overtaken but got ahead of the growth of population, until the dangerous state has been reached at which some three-quarters of our food comes from overseas. What have science and invention done to bring this about?

Before attempting to answer this question, let me point out in passing how preservation by drying still holds its own and supplies the basin of the Mediterranean and South America with Lenten fish in the form of dried cod from Scotland and from Canada, whence it comes in small sailing



STUDIES IN CORROSION.

An interior view of the canning laboratory showing the apparatus used in the study of corrosion

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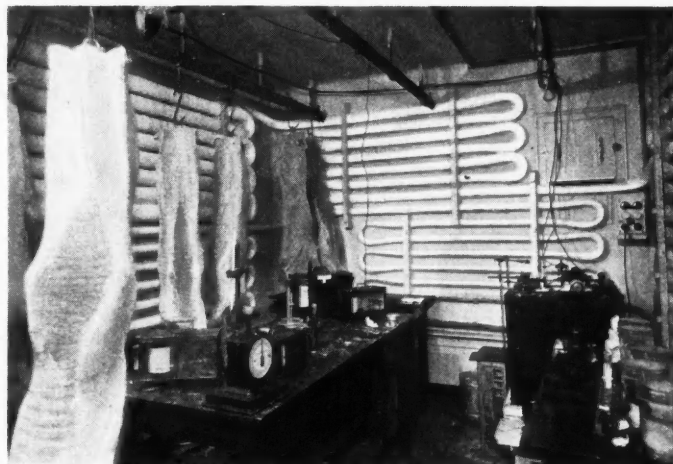
vessels. Let me also recall the way in which fresh cod was brought from the northern parts of the North Sea and the Faroes Bank alive in "well smacks," so called because of the well into which sea water could flow through holes in the bottom of the vessel. The modern era of plentiful and stable food supplies depends, so far as

these islands are concerned upon improved transport and the use of cold to prolong the "life" of perishable products. The former consisted mainly in the replacement of sails by steam, and the latter in the application of an inverted heat engine to pump the heat out of enclosed spaces.

It is just fifty years ago since the first cargo of frozen meat was brought from New Zealand to London. It was an anxious voyage, many unforeseen difficulties arose, among which was the condensation of vapour in the cold air tunnels as snow, which so choked them up that the smallest boy on board had to crawl through to sweep it out. Sails overlapped steam for a long time; I can well recall the smart little schooners which brought oranges from the Azores to Falmouth and the grain fleet of fine clippers which crowded the outer anchorage of Falmouth while waiting for orders.

A lot has been learnt about the application of cold and a lot still has to be learnt. It is used in two distinct ways, to chill the produce—meat, fish or fruit or to freeze it. Carcases of meat chilled, that is, carried just above their freezing point, have a "life" of about four weeks and that suffices to bring them from the Argentine. But there is a steady body of research endeavouring by various means to increase the "life" of chilled meat. The alternative to chilling is freezing, and frozen carcases are not only more easily handled because they are hard and resist pressure, but they will keep fresh practically indefinitely.

Another aim of research therefore is to improve the freezing process so as to transfer as much as possible of the carriage from the chilled to the frozen state. The difficulties of freezing are two-fold; one a matter



A CONSTANT TEMPERATURE LABORATORY.
One of the problems of research is the delicate regulation of temperature to entail the least wastage.

of prejudice and the other a curious scientific fact, namely the unexpected amount of change meat or fish undergoes in the frozen state. The prejudice on the part of the public against meat or fish which has been frozen is a real obstacle to progress, it is undoubtedly dying, but it is not dying fast enough. It is an inheritance

from the early days of freezing when the process was used as a convenient way of saving derelict food from complete destruction. It was even supposed that freezing in some miraculous way, would recover partly decomposed food by restoring its freshness. The methods of freezing in early days were crude, with the result that the product, even though it was of first-class quality when frozen, had lost both flavour and texture on thawing. The technique of freezing was immensely advanced by the discovery that both texture and flavour were better preserved the more rapid the cooling.

To carry out "rapid freezing" it is usual, indeed necessary, to use an agent capable of extracting heat much more quickly than can cold air. Saturated brine at -20°C . was first employed but much lower temperatures have since found their way into commercial practice, -45°C . being, I believe, the lowest. Small pieces of meat frozen by immersion in a cooling liquid at less than -20°C . have, on thawing, not only the texture and flavour of fresh unfrozen meat but the chemical changes which the natural ferments in it produce are the same. In slowly frozen meat the path of chemical change differs from that of unfrozen meat. The process of "rapid freezing" has, however, only a limited application because it is not possible to extract the heat fast enough from large carcases.

There is still another snag, an unexpected one. In order to bring fish home from a distant fishing ground, such as the Greenland banks, or to bring meat from Australia it must be held in the frozen condition for some weeks. Now it has been found, and herein lies the unexpected, that flesh can and does change

surprisingly even when frozen. It does not, of course, putrefy but the proteins change physically and chemically so that in course of time all the good effects of rapid freezing are lost. Much laboratory research is now being devoted to these storage changes and I think I may say that the practical difficulty will be overcome even though the chemistry and physics of the changes may remain obscure.

Preserving Fruit.

Fruit is alive and must be preserved alive; it cannot be frozen because freezing both kills it and reduces the tissues to a pulpy mass. But it is not possible to name any temperature as specially suited for fruit, for no two species or even varieties behave alike. When our research started, more than ten years ago, we thought in innocent faith that an intensive study of one fruit would reveal facts applicable to all. That faith has not been justified; fruit is idiosyncratic to the point of absurdity. Take for example the best temperature of storage for different varieties of apples:—Newton Wonder, 34° F.; Bramley's Seedling, 37°—38° F.; and King Pippin, 40° F. There is neither rhyme nor reason in it. The banana, a temperate fruit, carries best at 54°—57° F. but the mango, typically a tropical fruit, best at 36° F.

It is not surprising that many years of experiment and of commercial trials have been necessary to develop the technique even so far as it has got now. The preservation of fruit differs in principle from the preservation of dead flesh, because, since the former is alive, the object is merely to decrease the rate of ripening. Broadly speaking, ripening consists in the conversion of starches to sugars and the development of certain chemical substances which confer flavour. These chemical changes go on more slowly the lower the temperature, hence the utility of cold in the storage of fruit.

But here again there are many difficulties on which I can only touch, but their extent may be judged from the fact that over ten years intensive work here and in other countries on the apple has failed to remove them all. They centre in the broad fact that living matter reacts in an extremely complex way to an attempt to control its life history. When the process of ripening is retarded the chemical changes depart from the normal, and abnormal products are apt to appear which, amongst other things alter flavour. Storage of fruit is an art based upon scientific findings, an art directed to getting a product both palatable and as near as possible to the normal.

Ripening can be retarded and the fruit preserved by means other than cold—there is for example the

scientifically interesting process called "gas storage." Fruit, like living matter generally, is an internal combustion engine in which material is burnt with the production of, amongst other things, the gas carbon dioxide. Fruit therefore, like the plant which bears it, breathes in oxygen and exhales carbon dioxide and water. It is therefore possible to delay the rate of change by increasing the back pressure of carbon dioxide. This, very roughly, is the basis of the method of preservation known as gas-storage. The fruit is stored in an atmosphere containing a certain percentage of carbon dioxide, the optimum percentage like the optimum temperature varying for different kinds. The efficacy of gas storage, however, varies with the temperature and the best results are obtained by combining it with a certain amount of cold.

It is a simple method which is giving unusually good results in commercial practice but the details, such, for example, as the best ratio of carbon dioxide and oxygen or the most effective range of temperature, have been worked out only for a single variety, the well-known Bramley's Seedling apple. The physiological constants which govern the practice of gas storage are being mapped out as fast as possible for other varieties and for other fruits in the Ditton Research Laboratory at East Malling, Kent.

It is slow work; a storage experiment lasts about six months and needs a supply of freshly gathered fruit and of the many thousands of apples needed each one must be narrowly inspected to see that it is normal and free from disease. Since the fruit harvest comes but once a year, only one experiment can be done in each year. This is not altogether an evil for it compels careful planning so that no experiment shall be wasted and it gives time in which to collate the enormous mass of figures. When the data are complete and the physiological constants are available for the storage engineer, they will represent the results of years of experiment, ranging from exact quantitative measurements lasting for months of the respiration of single apples to mass experiments for each of which 120 tons of apples are used.

Regulation of Temperature.

The need for large scale experiments lies in the fact that "scale" modifies and sometimes nullifies the results of small scale laboratory work. For example, one of the problems of the new science of biological engineering is to realise throughout a large enclosed space like a ship's hold the delicate regulation of temperature, of humidity and even of the composition of the air which will entail the least wastage of the produce.

The Arctic Air Route Expedition.

By G. R. Crone.

Assistant Librarian, Royal Geographical Society.

The recent return of the British Arctic Air Route Expedition under the leadership of Mr. H. G. Watkins marks the completion of the most important piece of work carried out by a British party in the Arctic for many years, and perhaps in either Polar region since the war. The work of the expedition is here described.

THE British Arctic Air-Route Expedition was prompted by the fact that the air route from western Europe to Canada, which crosses the smallest extent of open sea, lies through the Faroes, Iceland and Southern Greenland. The longest stretch of sea is 320 miles, from the Faroes to Iceland. Before being able to pronounce upon the feasibility of this route, it was necessary to survey carefully the coast and interior ice-cap of southern Greenland, to determine the altitude of the latter, to locate the position of the coastal ranges, and to obtain accurate meteorological data as to conditions on the ice-cap. But apart from these special aims, it was obvious that the expedition would be able to add greatly to scientific knowledge of Greenland.

Mr. H. G. Watkins, the organizer and leader of the party, had had previous experience of great value in Spitsbergen and Labrador, particularly in the use and care of Eskimo dogs. His companions numbered thirteen, a larger personnel than has been usual in the exploration of Greenland. Fifty Eskimo dogs were taken, and two de Havilland Moth planes. The party were all ski-ers and while in Greenland most of them learned to handle the Eskimo kayaks. As the record of their work shows, the characteristic of the expedition was the skilful blending of old and new methods. In equipment and organization, much help was received from government departments and from the Royal Geographical Society. H.R.H. the Prince of Wales was honorary President of the organizing committee.

The party sailed on board Shackleton's old ship, the *Quest*, early in July, 1930. The main base was established about thirty miles west of the Eskimo settlement of Angmagssalik, at the head of a fiord where a large glacier debouches from the interior. During their stay much valuable help was received from neighbouring Eskimo families, frequently upon their own initiative. In the first month stores were assembled and a large living hut and two hangars were built. A party then set out to establish a station on the ice-cap where a series of meteorological observations might be taken—one of the most important objects of the expedition. To secure a continuous record it was planned to maintain two observers there who would be relieved at intervals. At the outset considerable difficulty was met with in hauling the heavily loaded sledges up the steep front of the glacier. The surface of the ice-cap was much easier travelling and the station was set up about 140 miles west of the base. Two observers were left there and ultimately a series of readings extending over about seven months was obtained. With the exception of a similar station

established by the German expedition further north on the west coast, none such has been set up in the interior of Greenland.

Meanwhile the surveyors of the party had proceeded on board the *Quest* to survey the coast as far north as Kangerdlugsuak fiord, one of the planes co-operating. Some difficulty was experienced in finding a suitable taking-off place



HUNTING IN THE ARCTIC.

Before starting the members of the expedition had succeeded in mastering the Eskimo kayak, or hunting canoe, in order to support themselves by hunting and fishing. Mr. Watkins is seen in the photograph.



MR. COURTAULD'S CAMP.

The station where Mr. Courtauld remained consisted of a double-walled tent, ten feet in diameter, covered by a snow-house, with the instruments in adjoining shelters.

for it as the floating ice made the sea dangerous, but the problem was solved when an ice-free lake was discovered in the interior. One result of this survey was the location, thirty to forty miles north of the fiord, of a previously unknown range of mountains. Time did not permit of their being closely examined, as it was necessary to avoid allowing the ship to be frozen in. Their height, however, was estimated at 14,000 feet, which would make them the highest in the Arctic. While the plane was engaged in a series of strips of air photographs, the surveyors, working in a motor-boat from the *Quest*, mapped the coast line and provided a ground control for the air survey. The geologist was also fully employed.

The central station had already been relieved by one party, but the third relief found great difficulty in making its way inland, owing to a change in the weather. It arrived on 3rd December after a journey of thirty-nine days—to be compared with another journey of twelve days. Part of the material had perforce been abandoned on the way, and the time taken up by the journey in made it necessary to recast the plans. As it was impossible to furnish supplies for two men, and as the abandonment of the station would have been a severe blow to the success of the expedition, Mr. A. Courtauld, the second in command, who was suffering from frost bite, volunteered to remain there alone until relieved at the end of March. The station consisted of a double-walled tent, ten feet in diameter, covered by a snow-house with the instruments in adjoining shelters. Accordingly, leaving Courtauld with more than sufficient food, the remainder returned to the base.

During the winter active work in the field was naturally suspended, the energies of the party being

directed to hunting and to journeying to the Eskimo settlement for supplies. The weather was exceptionally stormy and both planes were badly damaged by gales, but only temporarily, as the mechanics with skill and ingenuity in the employment of substitutes were able to make good all the damage. On 9th March a relief party arrived in the neighbourhood of the central station. Owing to the drifts of snow they were unable to find it although they remained there for fifteen days. The leader then determined to return to the base as rapidly as possible—his supplies were running short—so that a fresh relief might be organized. Within two days of their return Watkins left with another party.

The news that relief had failed to reach Mr. Courtauld naturally created anxiety at home, for though he was amply provided with stores it was by no means unlikely that some accident might have befallen him. The Swedish airman, Captain Ahrenburg, was therefore commissioned to fly out to assist in finding the station. His flight was an exceedingly bold achievement considering the time of year and especially the danger from fog. The publicity given in the daily Press, some of it of a highly sensational nature, unfortunately caused the work of the expedition to be placed in false perspective. The relief party led by Mr. Watkins was regarded by them as little more than routine duty. Unaware of the stir created at home, Watkins carried out his journey according to plan, and in twelve days had found the Union Jack and ventilator, the sole visible signs of the station. The party had soon liberated Courtauld from his confinement none the



SURVEYING FROM THE AIR.

While the plane was engaged in a series of strips of air photographs, the surveyors mapped the coast line and provided a ground control for the air survey.

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A SLEDGE PARTY.

Mr. Watkins, the leader of the party, had had previous experience of great value particularly in the use and care of Eskimo dogs.

worse for his trying experiences. Indeed, it was only the appearance of Captain Ahrenburg flying overhead as they were returning to their base that apprised them that exceptional measures had been taken for Courtauld's relief.

The five months that Courtauld spent alone proved to have passed uneventfully. He modestly described them as an "untroubled life of ease." The earlier part was marked by strong gales from the north-west but from February onwards the weather became colder and finer. A heavy fall of snow on 4th January closed the passages but he was able to dig a way out and to continue the meteorological observations every three hours. The lowest temperature recorded was 64 degrees below zero. But on 21st March he was completely snowed in and further work was impossible. Until his relief he was confined to the tent, and experienced some discomfort from lack of fuel and light, paraffin having leaked away. That he was able to maintain health in these conditions is a tribute to the selection and quality of the rations.

Before the start of the various journeys which brought the work to a conclusion, one other achievement requires to be recorded. On 6th June, 1931, a party of three set out to explore the mountainous area north of the base camp centering round Mount Forel, a peak previously sighted by de Quervain in 1912 and estimated to be 11,200 feet in height. The

topography here is a series of roughly parallel ridges, increasing in height inland. Down the western side of the range flows a wide glacier, fed by tributaries from the mountain which afford easy access to the vicinity of Mount Forel. The surface was good going and 176 miles were covered in thirteen days' travelling. After prospecting routes to the summit, an ice dome, a promising line of approach was selected up a ridge from a col on the south-south-west. Ice slopes, treacherous snow and rotten rock presented formidable obstacles to the ascent, but on the final assault a height of 10,880 feet was reached, the highest climb so far accomplished in the Arctic. On the return journey, in the course of survey work, four other peaks averaging approximately 10,000 feet were scaled.

The expedition's work wound up with three fine journeys; two crossings to the west Greenland coast—to Ivigtuk and to Holstensburg—and a journey down the coast from Angmagsalik round Cape Farewell to Julianehaab. Before starting the members succeeded in acquiring mastery of the Eskimo kayak, or hunting canoe, so that they might support themselves by hunting and fishing. Some even acquired the Eskimo knack of rolling right round under the water and coming up on the other side, an expedient to be used should the kayak capsize. The trip to Julianehaab under Mr. Watkins' leadership was made by motor-boat on which two kyaks were carried—one

man hunting to support the party on seal, fish and birds. A survey was made of the first 120 miles of this imperfectly charted coast, resulting in the discovery, amongst others, of an island forty miles long previously seen from the air. Various difficulties were encountered en route, arising from the weather and defects in the engine, but the journey of 550 miles was successfully carried out—though with only one gallon of petrol to spare.

The journey to Ivigtut was planned to supplement knowledge of the profile and altitude of the ice-cap, information very necessary in the planning of an air route. Most of the travelling was done at night, since the snow surface was slushy during the summer days. The route lay south to Umivik fiord, whence Nansen made the first crossing in 1888, and then to the south-westwards. The highest point reached on the cap was about 9,000 feet. While traversing the western slopes, they were able to use sails on the sledges to increase their speed. The third journey was made by J. R. Rymill and Hampton, virtually along

the Arctic Circle to Holstensburg. The wet summer was the cause of many lakes and rivers on the ice-cap, and after almost crossing it they were compelled to abandon their sledges and to carry their supplies and kayaks in relays; finally they reached a branch of the Stromfiord and were able to take to the water. Holstensburg was reached after two months.

The recent return of the expedition marks the completion of the most important piece of work carried out by a British party in the Arctic for many years, and perhaps in either Polar region since the war. This bald account of the work should at least have brought out the qualities contributing to its success. As a leader, Mr. Watkins relied upon the initiative and experience of his companions, and all were quick to adapt their plans to varying circumstances. The methods employed were based on those of their predecessors, with additions suggested by intention and experience, such as the practise of "living on the country," the use of *kayaks* and the co-operation of planes and sledge parties.

A Mysterious People of the Sahara.

In the French Sahara, five hundred miles south of Algiers, there is a desolate country known as the M'Zab. It has no natural frontiers. There are only seven towns, five of which are grouped in a kind of rock crater in the desert. The architecture of the towns is unlike anything else in the world. In the early part of the eleventh century the M'Zabites migrated to this desolate rock desert, where there was no vegetation and practically no water. It is an amazing achievement when one thinks that every well, and there are thousands, is over a hundred feet deep and has been sunk by hand without the use of any modern implement. There have been periods of eighteen to twenty years without rain, but there is a greater variety of fruit trees and vegetables in the M'Zabite oases than in many of our European gardens.

All watering is done by an ingenious system of irrigation which ensures every square inch of ground being flooded at regular intervals with a minimum of labour. In each garden there are so many wells in proportion to its size. Leading from each there is an inclined path down which a camel walks pulling a rope. At the other end of the rope is a skin, normally resting on the water level. When the camel has reached the extremity of the path this comes to the surface and automatically empties itself into channels which carry the water to the gardens, where it is distributed according to the wants of the earth.

No one is allowed to smoke within the walls of the towns, there are no cafes, no music is permitted, the women never appear out of their houses and all goods are sold by auction! Until one has attended the auction market, which is held in the public square every evening two hours before sunset, it is difficult to believe that everything from a bundle of firewood to a rich carpet is bid for in whispers by the silent men who sit solemnly on the ground while the goods are carried round and displayed. It is an unforgettable spectacle.

Another custom which is peculiar to the people of the M'Zab is that no woman is ever allowed to leave the precincts of any of the seven towns. The husband or son will go away and ply his trade in the great cities, but the wife and daughter must remain behind in the desolate towns.

Unlike the other inhabitants of Algeria, the M'Zabites are governed by the elders of the church. Far from being primitive savages they were cultivated and civilized before the Norman Conquest and have a great contempt for Europeans. No one is quite agreed as to their origin. All their characteristics seem to point to their descent from a very definite stock which is certainly not Arab, and though possibly Semitic is much more likely Carthaginian. The fact can only remain that the M'Zabite belongs to one of the oldest and strangest races of the world.—*China Journal*.

Producing High-Speed Protons.

The Carnegie Institution of Washington announces that photographs have been made of high-speed protons produced artificially in the laboratory. The steps which led to this important achievement are reviewed in the following report.

FOR the first time in the history of research on the structure of the atom, some American scientists have succeeded in observing and photographing the paths made by high-speed protons which were produced artificially in the laboratory. They have also succeeded in making preliminary measurements of the distance these protons will travel in air, thereby obtaining a clue to the law which governs their paths.

On February 28th the Carnegie Institution announced that this new achievement in the field of atomic physics had been made by Messrs. M. A. Tuve, L. R. Hafstad and O. Dahl of its Department of Terrestrial Magnetism.

Earlier Investigations.

According to views now generally accepted, protons—hydrogen nuclei—are the positive electric charges which along with electrons (negative charges) constitute the structure of the atom. For thirty years the problem of the atom has occupied brilliant investigators in all parts of the world, with the result that remarkable progress has been made in this unusually difficult research. In the course of this period a method of attacking the problems relating to behaviour of protons and electrons has emerged which the Carnegie Institution scientists have now begun to employ.

For example, the paths of high-speed alpha-particles which are spontaneously emitted from radium and which are now known to be the nuclei of helium atoms, were first made visible and photographed as streaks of fog in a chamber containing water vapour by Professor C. T. R. Wilson in England in 1912. Ten years later another Englishman, Dr. P. M. S. Blackett, used the same technique to demonstrate and study the paths of high-speed protons which he produced by bombarding hydrogen atoms with the alpha-particles emanating from radium. So also it has recently been reported that a similar technique has been employed by Dr. Anderson at the Norman Bridge Laboratory at Pasadena, in demonstrating that the so-called cosmic ray knocks both protons and electrons out of the nuclei of oxygen and nitrogen atoms.

In the achievements just mentioned, however, the source of the high-speed projectiles used in separating protons and electrons was that of radioactive substances such as radium and, in the last instance

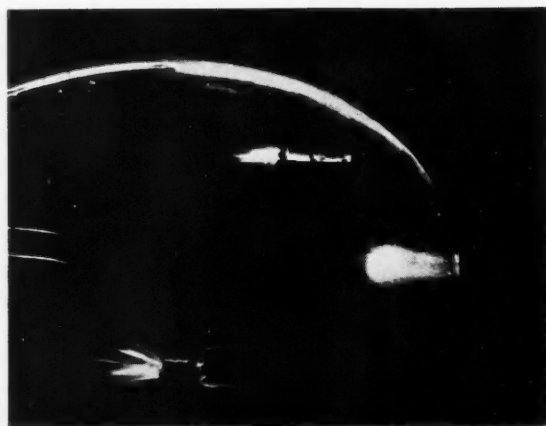
cited, the very powerful cosmic rays coming, it is thought, from some unknown source out in space. The need for a laboratory source which could be controlled at will has long been recognized.

The distinctive feature of the work of the Carnegie scientists lies in the fact that, while employing essentially the same observational methods, they have dealt with protons produced in the laboratory through employment of an extremely high electrical voltage. This, in turn, has enabled them to obtain a clue to the law which governs the relation between the distance protons will travel in air and their speed—the latter (when protons are artificially produced) depending upon the voltage applied to the high-voltage vacuum tube.

Investigation has revealed that matter, in all its forms, is made up of ninety-two different kinds of atoms grouped into molecules which, combined in countless numbers, constitute the objects we see about us. The atoms themselves, all of about the same size, are almost inconceivably small, being of the order of a hundred-millionth of an inch in diameter. They all have similar structures, being built up of fundamental separate unit-particles of positive and negative electricity, already referred to as protons and electrons. Each atom has a central positively charged nucleus surrounded by an atmosphere of electrons whose number and configuration determine the kind of atom it is—whether oxygen, sodium, platinum, radium, or some other of the ninety-two elements.

Modern Instruments.

It is known that almost the entire mass of the atom is located in this central nucleus, which is very much smaller than the atom itself, having a diameter of the order of one ten-thousandth of one-hundredth millionth of an inch. Although modern microscopes are very powerful, even the best of these fail the scientist long before the atom is reached. In study of the atom and its structure, therefore, indirect methods must be employed. The brilliant successes so far achieved in this field are due to the fact that instruments and methods have been devised by which atoms can be caused to emit radiations (light and X-rays) and can even be disrupted into their constituent particles, for example, by knocking off electrons. The effects produced by this breakdown of their structure



HIGH SPEED PROTONS.

The illustration shows tracks of high speed protons photographed in an apparatus known as the Wilson "cloud chamber," about one-third actual size.

can be observed. Thus positive conclusions are reached about the nature, behaviour and composition of a thing which is far too small ever to be seen.

Scientists have succeeded very well during the last thirty years in their studies of the external structure of the atom with ordinary laboratory equipment, but serious difficulties confront any attempt to study the nucleus of the atom. In fact, the very existence of this heavy, tightly packed, central core or nucleus in all atoms was first shown in 1911 by Professor Sir Ernest (now Lord) Rutherford, using the alpha-particles shot out from radium with energies measured by millions of volts. However, endeavours to learn anything about the atomic nucleus with ordinary methods met only with failure. Such agencies as high temperatures, extreme cold, electric discharges, enormous pressures, chemical explosions and the like have no effect on the atomic nucleus.

Measurement of the energies of the rays emitted by radium and the other elements of the radioactive family yield important information concerning these nuclei. In 1919 Rutherford first showed that the nuclei of lighter elements, such as nitrogen and aluminium, could be broken up by bombardment with the high energy alpha-particles from radium. Studies of the angles involved in collisions between these fast particles and the stationary nuclei of other atoms have yielded information concerning the sizes of atomic nuclei and the laws of force encountered near them.

For example, the size and shape of a barn might be determined by throwing a million tennis-balls at it and studying the number of balls which hit it and the angles at which they bounce off, even though

the barn were not visible. The principle involved in "collision studies" of the atomic nucleus is similar—the nucleus itself cannot be seen but the paths of the individual particles which bounce off from it can be studied in several ways, one method being by the Wilson cloud-chamber used in the proton experiments.

The information which can be obtained by the use of radium, however, is limited for two reasons, even neglecting the obstacle of its high cost. In the first place, all the radium in the world if collected in one place would give off only a known limited number of particles per second; and secondly the speeds and energies of the rays from radium are not subject to control. In particular, no rays are emitted whose energies are greater than a few million volts, which as regards the study of the nucleus has only begun to get into an interesting region of energies. A hope of obtaining a suitable substitute, yielding particles and rays under control and of even higher energies than those from radium, has depended upon the development of methods of producing very high voltages and applying them to vacuum tubes in the laboratory.

Enormous Energy.

If the electrically charged particles comprising an electric current are released between two metal electrodes to which a high voltage is applied, the particles will move toward the electrodes with tremendous speeds, due to the electrical attraction. If the particles are to attain full speed and maximum energy, they must be prevented from colliding with atoms of the air in their travel toward the electrodes. These electrodes, therefore, must be enclosed in a tube which is exhausted to a very high vacuum. When electrons are released at one electrode of a vacuum tube to which a high voltage is applied, they bombard the other electrode with speeds approaching the velocity of light, which is 186,000 miles per second.

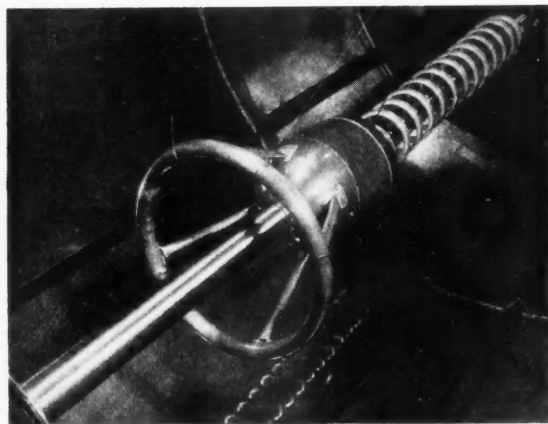
It is fairly easy with this method to knock electrons out of their normal positions in the atoms of a given element used as a target. Comparatively low voltages suffice to give a stream of electrons, used as projectiles, sufficient energy to accomplish this result. In order, however, to penetrate the central massive structure of the atom, the nucleus, the speed of the projectiles and consequently their hitting power must be increased enormously. This can be accomplished only by increasing the electrical pressure applied to the tube until it is of the order of several million volts. For some problems the projectiles must also be heavier than electrons; they may be positively charged atoms or nuclei. The production of such extreme

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voltages and their application to vacuum tubes, thereby obtaining streams of such high-speed particles, has been accomplished at the Carnegie Institution during the past few years.

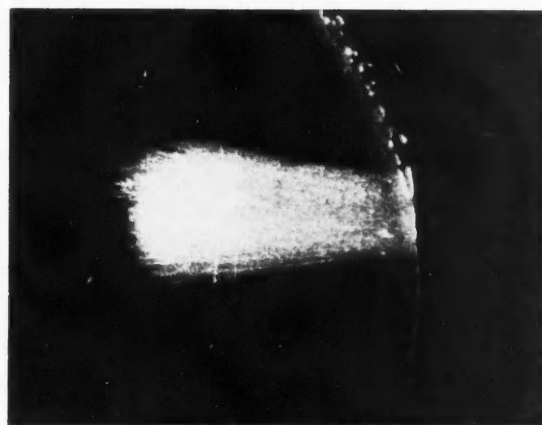
By the end of the first year (1927) the Carnegie scientists, using the ordinary Tesla Coil, had produced and measured in an open oil tank voltages up to three million. In oil, under pressure, potentials exceeding five million volts were obtained. Long-continued experiments with vacuum tubes resulted in 1929 in the development of such tubes which consistently withstand voltages above one million. These tubes are made on the "cascade principle" invented and first used by Dr. W. D. Coolidge of the General Electric Company. They consist simply of a number of X-ray tubes connected in series, with a hole through all of them. During 1930, with these Tesla coils and tubes, the Carnegie investigators verified the production of artificial beta-rays, which are very high-speed electrons, and artificial gamma-rays, which are very penetrating X-rays. Thus two of the three types of rays emitted by radium were duplicated in the laboratory.

Early in 1931 high-speed protons or hydrogen nuclei, similar to the high-speed helium nuclei or alpha-particles which are the third type of ray emitted by radium, were produced and measured in the laboratory at Washington. The energies of the artificial rays so far produced, however, do not yet equal the fastest of those emitted by radium. To accomplish this will not involve inherently new problems, as far as can be foreseen, but only an extension of the present equipment to dimensions suitable for still higher voltages.



TESLA COIL AND TUBE.

A view of the high voltage end of the Tesla coil and tube. The whole apparatus is immersed in oil during operation.



"SHAVING BRUSH."

A photograph of several hundred tracks made by individual high speed protons projected into a cloud chamber, forming a "shaving brush" effect.

As stated at the outset of this article, the most recent objective attained in the Carnegie programme has been the production of tracks in a Wilson cloud-chamber by high-speed protons from the high-voltage tubes. The cloud-chamber used in photographing the trails made by the protons is an ingenious piece of apparatus devised in 1912 by Professor C. T. R. Wilson, a distinguished English physicist. It was suggested by a series of earlier experiments by which it was shown that dust particles in the air are essential to the forming of clouds, it being difficult to make water vapour condense without the presence of such centres about which the droplets may form.

Wilson found that ionized molecules of air (air electrically charged) would serve quite as well as dust particles. Indeed, it is such ionized molecules in the upper air which gather the moisture about them and form our clouds. Wilson thereupon devised a chamber so arranged that he could shoot alpha-particles into its moisture-laden dust-free air, at one and the same time ionizing the air and producing droplets of condensed water vapour which reflect light when it is thrown upon them. Thus the trails made by these electrical particles become visible and can be photographed if desired.

Using this device Dr. Tuve and his associates at Washington have opened the way for extended studies of the details of nuclear collisions. The protons artificially produced and therefore accelerated under control to high speeds, are simpler projectiles than the alpha-particles from radium. In fact protons, along with electrons, have been called the building blocks of the Universe.

Progress in Medical Research.

Notable advance in the knowledge of many diseases is recorded in the latest report of the Council for Medical Research, of which the following are extracts. Recent work on viruses includes a renewed study of colds, which have hitherto eluded complete medical control; in this connexion some interesting experiments on apes are described.

AMONG outstanding advances in medical research during the past year is the notable progress made in the knowledge of nutrition. The discovery that a substance known as ergosterol is the "parent" of vitamin D has led to the commercial preparation of the vitamin on a large scale, since ergosterol is readily obtained in quantity from yeast. Meanwhile a group of workers at the National Institute for Medical Research have been engaged in studying the process by which the vitamin is produced from ergosterol by the action of ultra-violet rays, with the object of preparing the vitamin itself in pure form and examining its chemical nature. The problem has called for the close co-operation of physicists and chemists concerned with the improvement of methods, and of biologists.

New Discoveries.

This team of investigators succeeded early in the year in obtaining from the products gained by the irradiation of ergosterol a crystalline compound with constant and very high vitamin D activity and with well-defined chemical and physical properties. This they provisionally named "calciferol." During last autumn a further advance was made. It had been realized that calciferol, though it had an intense vitamin D activity, probably contained an inactive component. Chemical means were found for confirming this view, and for isolating in crystalline form what is apparently vitamin D itself or, if not, the nearest approximation to it yet obtained. This crystalline calciferol has intense biological activity. It has 400,000 times the value of a good sample of cod-liver oil in preventing or curing rickets. A certain daily ration of vitamin D is needed for the proper development and growth of every child. Lacking this, though it has otherwise abundant food, the child becomes stunted, deformed, and enfeebled. A single ounce of calciferol, dissolved in suitable liquid, could provide the necessary daily ration for more than a million children.

It seems almost incredible that a particular addition to the food so infinitesimal in amount, taken into the child's body for distribution to every part of it, should be so potent as to make all the difference between disease and healthy life. Similar instances of the significance in nutrition of the "infinitely little" are

provided, of course, by the other vitamins. We now have for the first time the description of a vitamin, or at least of a very close approximation to it, in terms of known chemical and physical characters. This is a notable advance, and high credit should be given to the ingenuity, skill and perseverance that have led to this new stage of knowledge. The attainment of accurate knowledge of vitamin D in terms of its chemical structure and physical properties is not merely a matter of academic interest. This information will in time be needed for gaining insight into the processes within the body by which this substance fits into the intimate biochemical machinery of the growing cell and the developing organs.

A more immediate practical advantage may come from our possession of a fixed stable substance by reference to which the vitamin D activity of any foodstuff or remedy can be measured. For some time past a standard of this kind has been held at the National Institute. This is a standard preparation of ergosterol which can be kept stable under right conditions. One unit of vitamin D is equivalent to one milligram of this solution. By international agreement last summer under the League of Nations, this standard is to be maintained at the Institute for world-wide reference. The attainment of accurate standards of measurement for the vitamins is a matter of direct public interest. As soon as knowledge makes it possible, the public should have effective guarantee that foods, whether brought from a distance or not, have the vitamin value which is claimed for them.

Commercial Production.

Another direction in which accurate knowledge of the physical chemistry of calciferol has practical use is in improving and cheapening large-scale production. There is good reason to believe that the majority of people living under urban conditions are living very near the minimum of adequate vitamin D supply, or below it. This applies especially to the young and actively growing. Work in the National Institute during the last few years has already led to the large-scale artificial production of vitamin D in this country. This has brought within sight the possibilities of great national saving in health and money. Proper development of the teeth and the jaws is impossible in the absence of

vitamin D. This was established several years ago as a result of experiments with animals and from observation of human dentition.

The improvement of the technical means of handling, seeing and measuring viruses has engaged the attention of medical research workers during the year. The viruses of yellow fever or foot-and-mouth disease are called "filterable" because they can pass through porcelain and other finely porous filters that hold back the ordinary bacteria, such as those that cause diphtheria or typhoid fever. Anything like uniform retention will obviously be effected only in so far as the holes in the filter are below a given size, and regularly so. For several years Dr. W. J. Elford has been engaged upon the purely physical problem of making filters of which the pores have both a uniform and a measurable size.

His new series of graded collodion membranes (called "gradocol" membranes), which meet these requirements, have now been in regular use for many months in the Institute and have already been of great service to the studies of different viruses. The pores through which the filtrate passes are closely uniform in size, and within each grade of filter the pores vary in diameter within only a very narrow range. It is possible, therefore, by use of the filters to gain a close estimate of the absolute and relative dimensions of the infective particles for each virus examined. A given virus, moreover, can be separated from other particles, whether of another virus or not, that are coarser than its own by a first filtration, and then be itself concentrated and washed free from finer particles on the surface of a second, higher graded, filter membrane. By this kind of selective concentration the chance of finding and identifying the particles of a specific virus by special microscopic methods has been greatly increased.

Ultra-violet Photography.

These results have been achieved with the help of recent progress in the design of new microscopic apparatus and the improvement of optical methods for the examination by ultra-violet photography of sub-microscopic organisms in the living condition. All the evidence now being accumulated by the use of new methods of ultra-filtration and ultra-microscopy tend to reinforce the opinion that some at least of the viruses examined are definite self-reproducing organisms, differing from the bacteria visible by the ordinary microscopic methods chiefly in being so minute that their diameter is much less than the wave-length of visible light rays.

Complete freedom has been given to skilled workers

to select particular virus diseases for study. These include the newly recognized mouse disease, infectious ectromelia, which was discovered and first described in a stock of mice received at the Institute. The arrival of this disease seems to have been a most fortunate accident, because the virus here happens to offer features that make it especially convenient for the pursuit of clues to its intimate nature and behaviour.

Many Studies.

Other subjects under investigation include foot - and - mouth disease, vaccinia, encephalitis lethargica, herpes, distemper in dogs, and transmissible malignant tumours of birds. They include also the virus-like agents known as bacteriophages which destroy bacteria, each "phage" having a highly specific action upon a particular race of bacteria towards which it behaves like the agent of a specific disease, enormously multiplying itself as it destroys.

It has often been made a reproach to the medical world that no effective control has been gained over the plague of the "common cold." There has long been reason to believe that the infective agent of colds is primarily a virus that may open the way for the invasion of various kinds of bacteria. The chief bar to progress in this direction has hitherto been the absence of a satisfactory experimental method, for neither the domestic animals nor the smaller rodents commonly used for laboratory work appear to be susceptible to colds. There has recently been made available in the United States a large fund which has made it possible to use chimpanzees for experiment, under conditions of rigid quarantine, unceasing attendance and control. It was found possible to transmit colds to these apes in nearly half of the attempts by the use of material derived from persons in the early stages of catarrh, and filtered so as to exclude bacteria. Clear evidence was obtained that the causal agent belonged to the virus group.

The next stage of the work, undertaken in the light of the knowledge thus gained, showed parallel results in the use of human volunteers. It was found, moreover, that the catarrhal virus could be cultivated outside the body in living cells from a chicken embryo, and could be passed through a series of sub-cultures. From these cultures the virus could be recovered, and could again produce typical catarrh in a susceptible individual. Dr. C. H. Andrewes, of the National Institute, visited this work in the past year, and an arrangement is now being made to extend it in this country. A generous supply of volunteers has been forthcoming from among the students at St

Bartholomew's Hospital. It is hoped that these, and the availability of the new culture method, will provide a sufficient experimental field to allow the costly use of chimpanzees to be avoided.

The chimpanzees under experiment showed that only a brief immunity succeeds infection by this catarrhal virus. In this respect it differs notably from other well-known viruses of disease such as those of measles or smallpox, where immunity after a first attack is long and commonly life-long. The brevity of catarrhal immunity diminishes the prospect of any rapid attainment of the means of practical control.

Tumours in Fowls.

For the past eight years Dr. W. E. Gye has been engaged in studying the cause of the malignant tumours that can be produced in fowls by the injection of cell-free filtrates from a tumour. These filtrates have infective properties closely parallel to those containing filterable viruses of other diseases, and indeed this work at its inception was designed as part of the general programme of virus studies to be promoted within the National Institute. Dr. Gye claims to have obtained two separate factors in tumour formation by suitable treatment of filtered tumour extracts. Evidence from experiments supports the view that in tumour filtrates we have to deal with an infective virus which, as regards the immunity reactions it can elicit, is similar in many respects to some of the acknowledged viruses causing specific diseases.

Readers of newspapers are familiar with the term "status lymphaticus," used very often at coroner's inquests into cases of sudden death to indicate a state of disease not recognized in life which is supposed to account for death when no other cause is apparent. The term has reference to a supposed over-development in the young, or abnormal persistence in the old, of the thymus gland in the neck, perhaps with a corresponding undue development of lymphatic tissue elsewhere. It has long been suspected that this disease has no real existence. It was suggested that medical men in many instances have been misled by the absence of properly recorded data of the normal size of the thymus gland, and of common variations about the normal, during healthy life. A man accustomed to the diminished thymus commonly seen in hospitals after death from fever or wasting illness might readily take as abnormal the size of the gland after sudden death in normal states of health and nutrition. Coroners from time to time have publicly expressed their doubt whether any real meaning can be attached to "status lymphaticus"

as providing an adequate cause of death. Even if such an abnormal condition does exist, it has not yet been adequately explained in what manner it can account for sudden death. There is an obvious danger lest the facile use of a verbalism of this kind may serve only to divert attention from the need for fuller inquiry into the actual cause of death.

In 1926 the Medical Research Council, in conjunction with the Pathological Society, organized a collective investigation of the disease. The main objects of the investigation were two: first, to establish by a large series of weights and measurements the standards of weight for age, and proportion to body-weight, of the normal thymus at all ages, and, second, to investigate closely the precise cause of death in persons dying suddenly from unexplained or trivial causes where the only apparent abnormality was the presence of a large thymus. This scheme involved the appointment of a number of investigators in large centres of population in Britain to collect detailed records upon special cards prepared and issued for the purpose. An analysis of the data collected shows that the inquiry may be regarded as having definitely established within narrow limits the average weights of the normal thymus for the several ages from one year upwards. The results provide "no evidence that so-called status lymphaticus has any existence as a pathological entity."

The extent to which insulin treatment has reduced mortality from diabetes in recent years is well known. Although there have been abundant supplies of insulin almost from the beginning of its manufacture in 1923, general use of the remedy has been advancing only gradually. It is believed that many patients are not receiving insulin under the necessary conditions of biochemical control and dietetic balance.

Deaths from Diabetes.

Attention has been drawn to the difficulty of interpreting the official figures given for death rates from diabetes in successive years since the introduction of insulin. The death rates were already subject to considerable fluctuation before that time and there is evidence that the disease has become more common since the war. The figures were based upon death certificates giving the diagnosis of contributory as well as immediate causes of death; and all deaths of diabetic patients, even if due to other illnesses or advanced age, have tended to find a place under the head of this disease.

A more important difficulty is that the effect of insulin is not to give radical cure but to prolong life. The results of the treatment, therefore, are to be

sought not in a reduction of the total mortality but decrease in deaths from diabetes in the earlier age groups. This decrease has been found to be large, although not yet as great as might have been expected. The most recently available figures show that since the introduction of insulin the mortality of male diabetics under 55 years of age has been reduced by 37 per cent and of females by 21 per cent; in the age group from 25 to 45 years the rate for males has fallen by as much as 45 per cent.

Insulin Treatment.

The Council has recently made an inquiry into the results of insulin treatment at various centres to discover the standard of success attained under the best conditions. A series of over a thousand cases of diabetes (under treatment at one centre in the period 1925-31) is now being analysed. Almost all the patients have been receiving insulin except in the highest age group, where many of the cases are of the mild and slowly progressive type which is commonly found in elderly subjects; this can often be more conveniently controlled by dietetic measures alone.

The whole period of experience in treatment by insulin covers only eight years at the most. It has been found that the figures for young and middle-aged subjects show a great preponderance of cases where good health is still maintained against all expectations based on previous experience. But the real gain is much greater than any figures can show. Without insulin, the patient, during his brief period of survival, soon fell into a state of increasing invalidism under dietetic restrictions amounting almost to starvation. The patient receiving insulin now retains or recovers a close equivalent of normal health and a full measure of mental vigour.

The problem of securing in the most rapid and effective way the trial of new substances giving promise of therapeutic value has long engaged the attention of the Medical Research Council. On special occasions in the past, as for instance upon the first introduction of insulin for the treatment of diabetes or of liver extracts for the treatment of pernicious anaemia, the Council have made special arrangements for suitable trials and reports by clinical observers. The production of new therapeutic agents seems certain to increase rather than to diminish, and in the last year a more regular machinery for the organization of clinical trials has been set up. The chemotherapy committee have been engaged in promoting the production of new synthetic substances of therapeutic importance, and in their biological examination. New synthetic compounds are put forward from time

to time for biological study in the laboratory, or for clinical trial.

The problem of securing trustworthy clinical trials of products produced by manufacturing firms is being dealt with. It has been urged that in this country the work of University laboratories, as well as that of chemical manufacturers, has sometimes failed to gain its proper reward in clinical usefulness because of the practical difficulties that have hitherto prevented early and effective clinical trials. In some other countries, and conspicuously in Germany, where the production of new synthetic substances is most active, physicians are ready to publish the results of clinical trials of new and patented substances over their own names. In Great Britain, professional men, for reasons that seem obvious here, have not in the same way been willing to use their names. It has not been uncommon, indeed, for a new substance first produced in this country to come into general recognition and use by way of clinical reports published in German or other foreign journals. Members of the medical profession in Great Britain have on more than one occasion had pressed upon their notice, under foreign names by the medium of foreign literature, substances which were British in first production but which have escaped notice and trial by clinicians here.

A number of distinguished clinical observers accepted last year an invitation to form a standing committee under whose supervision and authority clinical trials of new substances may be organized. As a result of consultation between the Chemotherapy Committee and the Association of British Chemical Manufacturers conditions have been accepted under which substances may be submitted for study. Trials of substances submitted to the committee and approved for this purpose have already been organized at suitable hospital centres and are now in progress.

Aid from Manufacturers.

The co-operation between manufacturers and research workers is reflected in the gifts which the Council has received from time to time from commercial firms. Developments in the manufacture of insulin have, as already noted, been assisted by special research work. This has led not only to greatly increased output but to a rapid fall in cost. Assistance has also been given by the study of methods for the production of vitamin D, of various organic extracts used in medical work and of material used for inoculation against distemper in dogs. At the same time manufacturing firms have reciprocated in a generous way and have always been ready to offer the results of their experience.

Modern Methods in Oyster Farming.

By C. M. Yonge, D.Sc.

Marine Biological Association of the United Kingdom.

The oyster industry is the most important fishery in the United States. The author has just returned from a visit to the famous American beds, and here describes the modern system of "farming" adopted by the oystermen there. It is suggested that the British oyster industry has much to learn from American methods.

WHEN the colonists from Europe first landed in North America they found the shallow coastal waters along the Atlantic coast teeming with oysters, from the Gulf of Mexico in the south to the coasts of Massachusetts in the north. The sheltered waters of the great Chesapeake Bay, the mouth of the Delaware river and Long Island Sound appeared to be inexhaustible reservoirs of these animals, and must in their original state have contained the most extensive oyster beds in the world.

The American Oyster.

The American oyster (*Ostrea virginica*), usually known in this country as the blue point, differs from the English "native" (*O. edulis*) in many ways. In shape it is more triangular and has a greater internal capacity than the flatter, rounded native. Unlike that species it does not change its sex every time it discharges sexual products which always pass into the water, the young embryos never being retained in the mantle cavity as they are in the native. Finally it needs higher summer temperatures, for it will not spawn until the water reaches a temperature of 20°C., whereas the native spawns at 15°C. In almost every particular it resembles the Portuguese oyster (*O. angulata*) which is now the predominant species on the French beds.

For many years after the establishment of the American colonies the inhabitants merely gathered the surplus products of the oyster beds, and probably did these more good than harm. But as the population of the eastern seaboard rapidly developed after the establishment of the United States and the great increase in immigration during the last century, the oyster beds were seriously affected in two ways. The intensive fishing of some of the smaller beds near the large centres of population resulted, owing to the lack of any measures of control, in their almost complete destruction. The Massachusetts beds, once famous for their fine oysters, are now almost completely denuded, while even the immense harvest from Chesapeake Bay has fallen considerably. But in addition to overfishing, the oyster beds in the industrial regions were either destroyed or else rendered unfit for human consumption by the

ever-increasing pollution of the water. At one time there were important beds in the lower reaches of the Hudson River, below New York, but pollution has completely destroyed this fishery.

A recent invitation from the Oyster Dealers' Association and the National Shellfish Association of the United States, made possible a tour of inspection of the American beds from the Delaware River in the south to Rhode Island in the north. An opportunity was thus presented to inspect the modern methods which the Americans employ to grapple with the problems of increasing demand and the possible depletion of their beds. In spite of overfishing and pollution the oyster industry is to-day the most important fishery in the United States. Nearly six thousand million oysters are marketed every year, representing some seventy-three thousand tons of food and a value of over three million pounds. Over sixty-three thousand people are employed in the industry.

This great industry is based on something far more permanent than the old method of reaping the marine harvests without care for the future crops. To-day, although the southern beds are still public property, and the problem there is one of thinning out rather than replenishing—for the oysters tend to overgrow and kill each other—the most important beds are carefully controlled. A short description of the modern organization of the oyster industry at the three principal northern sections, the Delaware river, Long Island Sound off the coasts of Connecticut, and Naragansett Bay in the State of Rhode Island, will give some indication of the nature and success of this extensive farming.

Amazing Fecundity.

The oyster lives in shallow water, is amazingly fecund—the American oyster may produce over one hundred million eggs every time it spawns, which may be several times during the summer—feeds on the microscopic floating plant life in the water, and demands a clean hard surface on which to settle. It was the appreciation of these facts which led to the development of the French oyster industry, and a similar application of the results of marine biological

research has enabled the Americans to overcome the disastrous effects of overfishing and pollution.

The great natural oyster beds in the upper reaches of the estuary of the Delaware river are the property of the State of New Jersey. They are carefully guarded as a great natural asset. For the months of May and June they are thrown open to the oystermen, and during this period a fleet of almost three hundred sailing schooners works over them, gathering young oysters for transplantation to the privately leased grounds further out to sea. All empty shells are thrown back on to the beds and many other shells are also planted. These provide a perfect surface on which the young oysters, which will appear in millions as soon as spawning begins in July, can settle. In this way a series of isolated beds has been converted into one great bed twenty miles long and about five miles wide.

Every year nearly five million bushels of young oysters are removed from the natural beds and relaid in the shallow waters of Delaware Bay, where the abundant supplies of the oysters' microscopic plant food ensures their very rapid growth and "fattening." But the water there is too saline for the oysters to spawn well and the currents are too powerful to allow the young oysters or "spat" to settle as they do on the natural beds. No less than thirty thousand acres of the bay are now leased to oystermen. The boundaries of the different grounds are marked by stakes, the projecting tops of which everywhere break the surface of the sea in a bewildering manner, but to the oystermen the wide waters of the bay are as familiar as are the streets of a town to its inhabitants.

During the season, September to April, the oyster boats, relying now mainly on their auxiliary motor power which they are forbidden to use on the natural beds, dredge over the beds. Two dredges are employed alternately; as soon as one is drawn up on the one side the second is let down on the other. They are secured by stout chains which pass over blocks

attached to a massive post in the middle of the deck and thence to the winch below decks. The machinery is controlled by the captain, who occupies a commanding position in the wheel-house. The dredges have strong iron frames and a capacious bag of steel links, and after a few minutes on the bottom they are drawn up full almost to the brim with oysters. At the end of the day, with decks piled high with oysters, the boats return. But before the oysters

are marketed they are first stored in barges which are supported by pontoons level with the surface of the water. This is done because the water in the bay is muddy and the oysters must be given time to discharge the mud they have collected. The barges are arranged in lines along the quiet reaches of Maurice River Cove, where the less saline water causes the tissues of the oysters to swell a little.

Some four hundred million oysters are landed annually at Bivalve, the centre of the industry. Many are marketed in the shell, but even more are first opened and the oysters, after thorough washing, canned and then stored and sent away in ice. This process is known as "shucking," and the great shucking houses are a prominent feature at every centre of the industry. Besides each one is a small mountain of empty oyster shells. Some of these are thrown back on to the natural beds, to form

"cultch" on which the oyster spat can settle; others form the raw material for the manufacture of chicken grit or are burned for lime.

The oyster industry on the Delaware river is self-contained and has attained its present dimensions by taking judicious advantage of its natural assets, as a result of admirable state legislation and co-operation among the oystermen. The industries on Long Island Sound and in Narragansett Bay are both specialized and each depends to a large extent on the other. Just as Arcachon in France is the great centre of "seed" production, young oysters being sent to the other French beds and even to this country, so is the



PESTS OF THE OYSTERS.

The photograph shows a barrel of starfish, the chief oyster pest, being tipped on to the deck after being killed by steam.

Connecticut coast which borders Long Island Sound the great centre for seed production in America. This is a highly industrialized area and pollution has made the growing of oysters for the market impossible in most of the inlets, but pollution does not affect spawning and subsequent settlement of the spat. Nowhere along the coasts are such abundant spat falls obtained, and full advantage of this has been taken by the local growers.

Every year, immediately before the spawning period, thousands of bushels of empty shells of all kinds are thrown over the beds to provide settling areas for the spat. The cardboard partitions from egg boxes, covered with a thin coating of cement, are also used and owing to their great surface become covered with an incredible number of young oysters. Wire netting bags full of empty shells are another form of artificial "collector." At the end of the summer the young oysters are dredged up and transferred to grounds farther off shore where conditions are more favourable to feeding and growth. When two years old they are again dredged up and sold to growers who possess good grounds for the growth of oysters where there is no pollution, but who cannot themselves obtain adequate supplies of spat.

Such grounds occur on the seaward side of Long Island, particularly at Sayville, which is the site of the Blue Points Company whose products are responsible for the English name for the American oyster, and particularly in the extensive reaches of Naragansett Bay in Rhode Island. The extremely abundant microscopic plant life of these saline waters enables the oysters to grow rapidly and develop very plump bodies; the finest oysters I saw in America were those dredged in Naragansett Bay. Very large boats, some of them steam driven, are used to collect



BRINGING IN THE DREDGE.

Nearly six thousand million oysters are marketed every year in the United States and over sixty-three thousand people are employed in the industry.



OYSTER DREDGER AT WORK.

During the season, from September until April, the oyster boats, using motor power which is forbidden on the natural beds, dredge over Delaware Bay.

this rich harvest and to scatter the young oysters, purchased from the Connecticut growers, on the beds. Each oysterman divides his grounds up in such a way that he has a continual rotation of crops; as soon as one crop attains maturity it is dredged up and young oysters are laid down on the empty ground.

But such vast accumulations cannot be laid on the sea bottom without attracting an equally large population of animals which prey upon them. Pests are a serious problem on all the oyster beds, a small univalve which drills a hole through the shell of the young oysters being especially troublesome in Delaware Bay. In Rhode Island, however, starfish, which are everywhere a pest, reach alarming numbers. I have never seen such immense numbers.

The vessels steam slowly over the beds dragging mop tangles consisting of an iron bar about ten feet long to which are fastened eight or more mops of strong cotton yarn about four feet long. These sweep over the surface of the beds, and the starfish, covered as they are with fine spines, are entangled in them. After a few minutes the tangle is brought up—that on the other side being lowered at the same time—and is invariably covered with starfish. These are removed and shovelled into a large barrel. Into this a pipe projects through which a jet of steam is forced, immediately killing the animals. The great heaps which accumulate at the end of a day's work are landed and used as manure.

Such in brief outline is the modern American oyster industry. It is an example of the effect of wise legislation based on the results of scientific research combined with the understanding co-operation of the oyster growers. We can only hope that the English oyster industry will someday attain to the same degree of organization and efficiency.

Book Reviews.

The Work, Wealth and Happiness of Mankind. By H. G. WELLS.
(Heinemann. 10s. 6d.).

In many ways this is the most interesting of the remarkable volumes in which Mr. Wells has provided a survey of modern knowledge. The "Outline of History" and the "Science of Life" necessarily gave limited scope for the author's own ideas, being mainly a record of facts and achievements. In this latest work he is able to develop the social theories which will be familiar to readers of his novels. But in the case of the characters through whom these theories have hitherto been expressed, it was hard to decide how far they illustrated the author's own views, which are now clearly set forth in "The Work, Wealth and Happiness of Mankind."

Most of the critics have already admitted that it is impossible to review an encyclopaedic work of more than eight hundred pages, each of which contains the germ of a separate book. Mr. Wells explains that he is attempting no less than an outline of the whole of human activities, and he suggests that it should form the basis of more extensive treatment on the part of later authors. We can therefore do no more than select a few passages for comment.

In reviewing the "Science of Life" in these columns we strongly opposed the suggestion that man was nothing more than a machine. We are glad that Mr. Wells is now able to present a broader view of the problem. "It is impossible," he says, "to dismiss mystery from life. Mystery is all about us and in us, the Inconceivable permeates us, it is 'closer than breathing and nearer than hands and feet.' For all we know, that which we are may rise at death from living, as an intent player wakes up from his absorption when a game comes to an end, or as a spectator turns his eyes from the stage as the curtain falls, to look at the auditorium he has for a time forgotten." But Mr. Wells is content to leave it at that, for although ultimately the mystery may be the only thing that matters, "within the rules and limits of the game of life, when you are catching trains or paying bills or earning a living, the mystery does not matter at all."

The book is divided into sixteen chapters, covering such varied subjects as the conquest of hunger, why people work, and the rich and poor. Dealing with power, Mr. Wells mentions a new apparatus which is likely to have an enormous effect on the future. In the Kaiser Wilhelm Institute at Dalhem, Dr. Lange has, it appears, run a small electric motor by sunlight, passing the light through a photo-electric cell. "This little motor of Dr. Lange's may figure in the economic histories of the future as Hero's steam engine figures in those of to-day." But the possibilities of existing appliances are by no means exhausted. We are, for example, only on the threshold of the electrification of transport; out of 20,000 miles of railway line in Great Britain only 400 are as yet electrified; while the United States has less than 1,500 miles out of 236,000 miles.

Mr. Wells is continually finding that nationalism and other traditional barriers are holding up developments which could immensely benefit mankind. In the interests of aviation he urges a great effort in the development of meteorological science so that the aviator may plan his route with assurance, free from surprises by rain, snow, fog and tempest. "Only by evolving a cosmopolitan organization can meteorology achieve that manifest task before it." The same applies to wireless communication. The possibilities are boundless, yet the ether is becoming over-crowded and powerful stations are so increasing

their range as to interfere with reception thousands of miles away. Even signals of distress from ships at sea are said to have been drowned. "This destructive competition will in the end benefit nobody and lead to nothing but a deadlock unless it can be solved by international agreement." Mr. Wells quotes *Discovery* (May, 1931) in describing a new "ultra short wave" radio set with which conversations were exchanged between Dover and Calais on a wave-length of only eighteen centimetres. The aerials were less than an inch in length, and the power only half a watt, which is just sufficient to light an ordinary flash-lamp bulb.

There can be no doubt at all as to the benefits that science has conferred on mankind. Perhaps this point of view is most clearly shown by a paragraph relating to the development of ships and ocean transport. The author refers to the elimination of human suffering that has gone on at the same time, not simply the heroic suffering of shipwreck and famine, but in the conditions aboard the small sailing ship far from land, which "was often a pit not simply of deprivation but of cruelty." The galley slave was a slave, but throughout the eighteenth and early nineteenth centuries the sailors were among the poorest and most evilly treated of labourers. "Almost inadvertently science and invention have lit and cleansed those miserable caskets of oppression beneath the tall masts and the belling sails of the old order of things at sea."

Scientific research, Mr. Wells believes, is the modern form of the religious life, which gives courage and a fundamental serenity, and is the pathway to great adventures and limitless service. Although its "pay and endowment are the least of its rewards," it is satisfactory to note that over two million copies of the "Outline of History" have already been sold, and we predict another large demand for this latest volume.

Science To-day and To-morrow. By SIR FRANK DYSON AND OTHERS. (Williams and Norgate. 8s. 6d.).

The essays collected in this book are based on lectures delivered at Morley College and the authors need no introduction. Sir Frank Dyson writes on astronomy, Professor Elliot Smith on anthropology, Dr. Joseph Needham on biology, Sir Arthur W. Hill on botany, and there are other distinguished contributors. The Astronomer Royal suggests that, while in old times people looked at the stars and thought they might have some influence on human affairs, nowadays we do not trouble to do so, although we all read about "The Mysterious Universe." As the optical power of telescopes has increased many new members of the Solar System have been discovered. Only last year a distant star was discovered from Arizona. Quite lately big stellar distances have been got in a new and interesting way.

Professor Elliot Smith urges the elimination of personal bias and acquired prejudice in anthropological studies. This is an inevitable result of civilization and is responsible, he says, for the diversity of opinion concerning the fundamental issues involved in anthropology and the lack of discipline in technical methods. Much of the confusion is due to a neglect to give due consideration to the distinctive attributes of mankind, the qualities which differentiate men from all living creatures. "In formulating speculations based upon an assumed evolution of culture, it is the common practice to neglect the distinctively human qualities of mankind, the very factors which enable man to do what no other creature can do, namely, to create culture and to devise a system of civilization."

The discussion of biology to-day and to-morrow, writes Dr.

Needham, is a futile occupation unless we have in our minds the state of biology yesterday. For one of the most distinguishing marks about the civilization to which we belong is just that capacity for seeing ourselves as one unit in a time-chain of other units, reaching backwards, as it were, down a brightly-lit tunnel and forwards into impenetrable darkness. The biology of to-morrow will be quantitative, statistical, experimental. It will be in some respects more complicated and in others more simple. It will have some understanding of the nature of biological organization, an understanding which we at present have not. The past did not begin yesterday, the present will not end to-morrow, and we must see ourselves as the links in a very long chain. This prevents us from supposing that wisdom was born with us or that we are the highest product of evolution, the crowning achievement of the universe.

Sir Arthur Hill reviews the changes which systematic botany has undergone in the past few years. With a closer and more intensive study of plants we find that among plants hitherto regarded as the same species many varietal forms can be found, either coming from different regions or from different altitudes, and it is also found that the different varieties or races tend to breed true to their special characteristics. In the case of plants which have no particular value from the economic point of view, these small differences are mainly of scientific interest. But in cases where plants yield important economic products the small varietal differences are of great importance, since it is found that in some cases a particular variety may yield the desired product in large quantities, while in other varietal forms the product may either be present in small quantities or may not occur at all.

There are other chapters on psychology, chemistry, medicine, mechanism and geology, and these scholarly and critical essays should make a wide appeal.

This Surprising World. By GERALD HEARD. (Cobden-Sanderson. 3s. 6d.).

Mr. Heard attempts to define "the main drive and inspiration of science." Science, he rightly maintains, is not a mode of thought completely different from all other modes—religion, art and philosophy. The author blames the "high specialization of working scientists" for the fact that this general direction of science and its kinship with the other modes of apprehending reality has been overlooked. We are not quite sure what it meant by that; Mr. Heard is no doubt referring to the belief, fortunately no longer justified, that the specialist is incapable or unwilling to serve the results of his work on a popular platter. So as a layman Mr. Heard has stepped into the breach. But he has been forestalled—by Sir Arthur Eddington in "The Nature of the Physical World," by Sir James Jeans in "The Universe Around Us," by Sir William Bragg in "Concerning the Nature of Things," by Sir Oliver Lodge in "Atoms and Rays." As to the "high specialization of working scientists," it would be difficult to know how many of the achievements of recent years science would have been able to claim without it.

The author suggests that, if the new advance of science has really gone beyond all other advances, it must do one of two things—it presages either an unprecedented collapse or an unprecedented enlargement and synthesis. It can lead, he says, to a collapse more complete than the last collapse of the empire of science, for we are on the brink of an age darker than the Dark Age. "The tentative age of science is over—when it touched psychology that epoch closed. We are done

with piece-meal applications of science to life. Life henceforward will become the inevitable resultant of science; science discoveries will not any longer have to be applied. Their discovery and their application will be the same act. The inevitable evolution of science has brought it to profounder wonders until it realizes that, strange as the world is, utterly different from the common-sense view, the strangest thing is science itself and its mysterious relation with the universe it relates. . . ."

The publishers are to be complimented on a model of modern book production. Type and binding are excellent, and the book is priced to meet the needs of the time.

Across New Guinea. By IVAN F. CHAMPION. With an Introduction by SIR HUBERT MURRAY. (Constable. 15s.).

This is an account of two attempts to cross New Guinea, the first of which was a failure and the second a great success. It is an absorbing story of adventure and scientific observation, modestly but graphically told by one of the leaders of the expeditions. New Guinea had already been crossed at its narrowest point, but this was the first attempt to follow the Fly River to its source, then to cross the central range, and to continue by way of the Sepik River. Difficulties with native carriers, sickness and lack of stores forced Mr. Charles Carius and the author to abandon their first attempt. But they had no sooner returned to their base than they commenced preparations for a second expedition. Although the explorers met with even greater difficulties than before, they eventually succeeded, in the words of Sir Hubert Murray, in the most difficult and most important work of exploration ever performed in these islands.

In the first part of the book Mr. Champion describes in turn the crossing of the Gulf of Papua, a boat trip up the Fly, the desertion and subsequent return of the carriers, the long trail to the mountains, the problem of coping with almost perpendicular mountains nine thousand feet in height, and finally the journey of five hundred miles down the Fly on rafts made by the explorers themselves. The second part of the book is an account of the crossing of a treacherous limestone range, "where a false step meant falling into an abyss or impalement upon needle-pointed pinnacles"; rafting on the Sepik; the trek through a maize of swamp and jungles; and many other thrilling adventures. As Sir Hubert points out, there is one fact which by itself speaks volumes for the tact, self-control and courage of the party: not a shot was fired during the whole expedition. A great part of the journey lay among strange natives and through unknown country, but tact and patience ensured the establishment of friendly relations even when the outlook was decidedly unpromising.

In the Grip of the Jungles. By GEORGE HOGAN KNOWLES. (Wright & Brown. 15s.).

This book is chiefly an account of big game hunting in the Himalayan jungle. It also claims "to present nature studies, so blended with stirring incidents as to give the reading a special value." Indeed, the nature study is so skilfully blended that to discover it calls for almost as much skill and perseverance as Mr. Knowles no doubt required in his trek through the jungle. But we do not wish to be difficult about a book which is really excellent of its kind. The author writes well and the

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"incidents" are really stirring, as the titles of some of the chapters suggest: "In a Dead City: A Strange Panther Hunt"; "On the Way to Buxar, and a Terrible Tiger Story"; "On the Tracks of a Man-eating Tiger"; and so on. Mr. Knowles is not of the class of "sportsmen" whom one pictures stalking their prey with a machine-gun. "In the matter of big game hunting," he writes, "where there is so much to interest one in 'nature study,' there is nothing so disappointing as to find one's jungle companions bloodthirsty shooters who vie with each other in that unsporting and unintellectual ambition to secure a 'boastful bag,' with all its petty jealousies and noisy pretensions. In this great department of 'sport,' shooting and hunting, there are two distinct classes of sportsmen of opposite extremes: the avaricious type who takes a tour of the jungle to kill all he can and who sees nothing; and the extreme true type who takes a tour of the jungle to see all he can and who shoots nothing. This last defined class, highest in degree, leads on to the various classes of true sportsmen who shoot, more or less, but always with the greatest discrimination, showing consideration for life of every description." It is not for us to suggest an apparent paradox in showing consideration for life of every description while "shooting more or less."

Growth and Development of the English Parish. By WRAY HUNT. (Harrap. 15s.).

In these days the word "parochial" has come to imply a narrowness which was not understood when the life of the individual turned upon his place in the parish. In this delightful book the author traces the development of the English parish from its beginnings in the King's Hall to the height of its religious influence and social prestige in the mid-nineteenth century. Although in our own day the parish has gradually become divested of its power, its influence has not altogether ceased to be felt. This book is intended to enable the reader to understand "the sort of people among whom the things happened which are described in political histories," for no one can understand the history of his country who does not understand its life and ideals.

In a concluding chapter the author writes: "Shorn of most of its power, the parish still has its place in our society, a place which is hard to define, yet none of us would care to be without it. The parish church reminds us of days when life was slower and perhaps fuller and workmanship more stable and more skilled. A comparison of the work put into Holsham Church with the hurried throwing up of machine-made bricks into an ugly heap that so often begins and ends of the art of building to-day, makes us wonder whether there was not something in those days that we might well seek to win back."

The Country of the Orinoco. By LADY DOROTHY MILLS. (Hutchinson. 15s.).

There is much that is of interest in this sprightly book in spite of the author's incorrigible journalese: "To linger where oil—the world's great motive power—bubbles from the sun-baked earth, to share the thrill of the white llanos, land of strong men and swift horses. . . . "Dishevelled, exceedingly dirty, tired to shakiness, with one eye bunged up, in half an hour I had scraped off the worst of the mud, allayed the worst of my hunger and thirst, and had dropped like a dead thing on to a hard bed, in a queer, ramshackle, friendly hotel. . . . "

Readers with a taste for so-called "descriptive writing" will be at home with Lady Dorothy. In the upper reaches of the Orinoco the author had many unusual experiences and in the forests of Venezuela little-known tribes "who hate the white man" were encountered. The author has something to say about their social and religious customs; but she is more interesting as a traveller than as an anthropologist. A word of praise is due to the publishers for the neat production of the book, and the index is an asset.

Backwaters. Excursions in the Shades. By JOHN GAWSWORTH, with an Essay by EDMUND BLUNDEN. (Denis Archer. 5s.).

There are four newly-discovered manuscripts in this charming and unusual volume. There is a letter from William Godwin dealing with the suicide of his friend, Holcroft's son—an appendix of major importance to the Hazlitt's edition of Holcroft's *Memoirs*; a sheaf of poems by the forgotten laureate, Henry James Pye; a letter from Lady Hester Stanhope at Mount Lebanon concerning the eccentricities of the prophet-general Lousaunau; and a correspondence of Leigh Hunt at the age of seventy. Mr. Gawsorth's comments are judicious; with a kindly pen he treats of the declining years of Leigh Hunt, and he is generous to the honest Pye of whom Scott declared "he was eminently respectable in everything save his poetry." It is a book that should interest all lovers of *Belles Lettres*.

The Search for Man's Ancestors. By G. ELLIOT SMITH. (Watts. 1s.).

In this little book the author presents a summary of the main facts of the discovery of the earliest known types of man—Java man, Piltown man and Peking man—and explains the inferences drawn from each in their bearing on the problem of man's origin and descent. He concludes by discussing the problem of man's place of origin, particularly in the light of the evidence for a relationship between pithecanthropus, Piltown man and Peking man. The book is written with Professor Elliot Smith's usual skill in lucid exposition of a technical subject.

Nature in Downland. By W. H. HUDSON. (Dent. 3s. 6d.).

A Sportsman's Sketches. By IVAN TURGENEV. Translated by CONSTANCE GARNETT. (Dent. 3s. 6d.).

With these delightful volumes the publishers introduce the Open-air Library, edited by Mr. Eric Fitch Daglish, each with a foreword and wood engravings by the editor. One cannot commend these charming little books too highly. The aim has been to gather together the most characteristic examples of "open-air books" concerned with nature and country life. "Nature in Downland" was first published in 1900 and is a true reflection of the author's quaint and mystic charm. "An Old Thorn," which is also incorporated in the book, came in 1920 and was enthusiastically received. Aspects of Russian country life are well portrayed in "A Sportsman's Sketches." The translator has done her work well. She has neither adhered too slavishly to the Russian text nor has her success in avoiding artificiality detracted from the character of the author's style. We welcome the re-publication of these stories in handy form. The production of the books leaves nothing to be desired.

The Literature of Discovery.

The following books are referred to by Sir Frederic Kenyon, Sir Arthur Thomson, Sir Oliver Lodge and Professor Debenham, in the articles on pages 105-III.

History and Archaeology.

- American Colonies in the Eighteenth Century.* By H. L. Osgood. (Oxford University Press.)
Archaeology in Roman Britain. By R. G. Collingwood. (Methuen.)
Architecture of Greece and Rome. By Dinsmoor and Ashby. (B. T. Batsford.)
Arts in Early England. By G. B. Brown. (Murray.)
Blenheim. By G. M. Trevelyan. (Longmans.)
British History in the Nineteenth Century. By G. M. Trevelyan. (Longmans.)
Chapters in the Administrative History of England. By T. F. Tout. (Manchester University Press.)
Correspondence of King George III, 1760-1783. By Sir John Fortescue. (Macmillan.)
Fasti of Ovid. By Sir James Frazer. (Macmillan.)
Five Centuries of Religion. By G. G. Coulton. (Cambridge University Press.)
Foreign Policy of Canning. By H. W. V. Temperley. (Bell.)
Foreign Policy of Castlereagh. By C. K. Webster. (Bell.)
Greek and Roman Architecture. By D. S. Robertson. (Cambridge University Press.)
History and Monuments of Ur. By C. J. Gadd. (Chatto & Windus.)
History of the Ancient World. By M. Rostovtzeff. (Oxford University Press.)
History of the British Army. By Sir John Fortescue. (Macmillan.)
History of England. By G. M. Trevelyan. (Longmans.)
History of English Law. By W. S. Holdsworth. (Methuen.)
History of France from the Death of Louis XI. By J. S. C. Bridge. (Oxford University Press.)
History of the Great War. By Sir J. E. Edmonds. (Macmillan.)
History of the Later Roman Empire, A.D. 395-565. By J. B. Bury. (Macmillan.)
History of the Tory Party. By K. Feiling. (Oxford University Press.)
Mohenjo-Daro. By Sir John Marshall. (Probsthain.)
Outline of History. By H. G. Wells. (Cassell.)
Palace of Minos. By Sir Arthur Evans. (Macmillan.)
Peninsular War. By Sir Charles Oman. (Oxford University Press.)
Prehistory. By M. C. Burkitt. (Cambridge University Press.)
Roman Republic. By W. E. Heitland. (Cambridge University Press.)
Social and Economic History of the Roman Empire. By M. Rostovtzeff. (Oxford University Press.)
Sumerians. By C. Leonard Woolley. (Oxford University Press.)
Tomb of Tutankhamen. By Howard Carter. (Cassell.)
Universal History. By J. A. Hammerton. (Amalgamated Press.)
Ur of the Chaldees. By C. Leonard Woolley. (Benn.)
Who Were the Greeks? By J. L. Myres. (Benn.)
Zimbabwe Culture. By G. Caton Thompson. (Oxford University Press.)

Biology.

- Age and Area.* By J. C. Willis. (Cambridge University Press.)
Animal Biology. By J. B. S. Haldane and Julian Huxley. (Oxford University Press.)
Animal Ecology. By C. Elton. (Sidgwick & Jackson.)
Antiquity of Man. By Sir Arthur Keith. (Williams & Norgate.)
Arcturus Adventure. By William Beebe. (Putnam.)
Biological Basis of Human Nature. By H. S. Jennings. (Norton.)
Biological Principles. By J. H. Woodger. (Kegan Paul.)
Biology in Human Affairs. Edited by E. M. East. (McGraw-Hill.)
Biology of Fishes. By H. M. Kyle. (Sidgwick & Jackson.)
Biology of Flowering Plants. By Macgregor Skene. (Sidgwick & Jackson.)
Biology of the Seashore. By Flattely & Walton. (Sidgwick & Jackson.)
Biology of Insects. By G. H. Carpenter. (Sidgwick & Jackson.)
Biology of Spiders. By T. H. Savory. (Sidgwick & Jackson.)
Birds of the British Isles. By T. A. Coward. (Warne.)
Common Plants. By Macgregor Skene. (Melrose.)
Conditioned Reflexes. By I. P. Pavlov. (Oxford University Press.)
Emergent Evolution. By C. Lloyd Morgan. (Williams & Norgate.)
Engines of the Human Body. By Sir Arthur Keith. (Williams & Norgate.)
Enzymes. By J. B. S. Haldane. (Longmans.)
Extinct Plants and Problems of Evolution. By D. H. Scott. (Macmillan.)
Forest, Steppe and Tundra. By M. D. Haviland. (Cambridge University Press.)
Galapagos Islands. By William Beebe. (Putnam.)
Genetic Principles in Medicine and Social Science. By Lancelot Hogben. (Williams & Norgate.)
Genetic Theory of Natural Selection. By R. A. Fisher. (Williams & Norgate.)

- Great White South.* By H. G. Ponting. (Duckworth.)
Human Biology and Human Welfare. Edited by E. V. Cowdry. (Lewis.)
How Animals Find Their Way About. By E. Rabaud. (Kegan Paul.)
Influence of Man on Animal Life in Scotland. By J. Ritchie. (Cambridge University Press.)
Interpretation of Development and Heredity. By E. S. Russell. (Clarendon Press.)
Introduction to Recent Advances in Comparative Physiology. By Lancelot Hogben and Frank Winton. (Collins.)
Introduction to the Study of Bird Behaviour. By H. Eliot Howard. (Cambridge University Press.)
Life in Inland Waters. By Kathleen Carpenter. (Sidgwick & Jackson.)
Modern Cat. By G. S. Gates. (Macmillan.)
Naturalization of Animals and Plants in New Zealand. By G. M. Thomson. (Cambridge University Press.)
Nature of Enzyme Action. By Sir William Bayliss. (Longmans.)
Nature of Living Matter. By Lancelot Hogben. (Kegan Paul.)
Origin of the Human Skeleton. By R. Broom. (Witherby.)
Philosophical Basis of Biology. By J. S. Haldane. (Hodder & Stoughton.)
Plant Life through the Ages. By A. C. Seward. (Cambridge University Press.)
Problems of Bird Migration. By A. L. Thomson. (Witherby.)
Science of Life. By H. G. Wells, J. Huxley and G. P. Wells. (Cassell.)
Short History of Biology. By Charles Singer. (Clarendon Press.)
The Seas. By C. M. Yonge and F. S. Russell. (Warne.)
Social Insects. By W. M. Wheeler. (Kegan Paul.)
Social Life in the Animal World. By F. Alverdes. (Kegan Paul.)
Social World of the Ants. By Auguste Forel. (Putnam.)
Study of Living Things. By E. S. Russell. (Methuen.)
Trend of the Race. By S. J. Holmes. (Constable.)
Unity of the Organism. By W. E. Ritter. (Badger.)
World's End Zoology. By William Beebe. (Putnam.)

Physics and Astronomy.

- Atom and the Bohr Theory of its Structure.* By Kramers and Holst. (Gyldendal.)
Atoms and Rays. By Sir Oliver Lodge. (Benn.)
Beyond the Electron. By Sir J. J. Thomson. (Cambridge University Press.)
Concerning the Nature of Things. By Sir William Bragg. (Bell.)
Introduction to the Study of Wave Mechanics. By de Broglie. (Methuen.)
Lectures on Theoretical Physics. By H. A. Lorentz. (Macmillan.)
Mechanics of the Atom. By Max Born. (Bell.)
Nature of the Physical World. By Sir Arthur Eddington. (Cambridge University Press.)
New Physics. By Haas. (Methuen.)
New Conceptions of Matter. By C. G. Darwin. (Bell.)
Physical Principles of the Quantum Theory. By Heisenberg. (Cambridge University Press.)
Quantum and its Interpretation. By Stanley Allen. (Methuen.)
Recent Developments in Atomic Theory. By Graetz. (Methuen.)
Science and Human Experience. By H. Dingle. (Williams & Norgate.)
Science and the Modern World. By A. Whitehead. (Cambridge University Press.)
Structure of the Atom. By E. N. da C. Andrade. (Bell.)
Theory of Spectra and Atomic Constitution. By Bohr. (Cambridge University Press.)
Universe Around Us. By Sir James Jeans. (Cambridge University Press.)
Universe in the Light of Modern Physics. By Max Planck. (Allen & Unwin.)
Vault of Heaven. By Sir Richard Gregory. (Methuen.)
Voyage in Space. By H. H. Turner. (Sheldon.)
Wave Mechanics of Free Electrons. By G. P. Thomson. (McGraw-Hill.)

Travel and Exploration.

- Across Arctic America.* By Knud Rasmussen. (Putnam.)
Arabia Felix. By Bertram Thomas. (Cape.)
Eaves of the World. By Reginald Farrer. (Arnold.)
Fight for Mount Everest. By Various Authors. (Arnold.)
Friendly Arctic. By V. Stefansson. (Macmillan.)
Green Hell. By J. Duguid. (Cape.)
In Quest of the Sun. By Alain Gerbault. (Hodder & Stoughton.)
Kanchenjunga Adventure. By F. S. Smythe. (Gollancz.)
Land of the Thunderbolt. By Lord Ronaldshay. (Constable.)
Lost Oases. By Hassanein Bey. (Thornton Butterworth.)
Rainbow Bridge. By Reginald Farrer. (Arnold.)
Revolt in the Desert. By T. E. Lawrence. (Cape.)
Serindia. By Sir Aurel Stein. (Heinemann.)
Seven Pillars of Wisdom. By T. E. Lawrence. (Cape.)
South. By Sir Ernest Shackleton. (Heinemann.)
Sun, Sand and Somalis. By Major Rayne. (Witherby.)
Tales of Travel. By Lord Curzon. (Hodder & Stoughton.)
Worst Journey in the World. By H. Cherry-Garrard. (Constable.)

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